VOL. 30, NO. 3 MARCH, 1953

AMERICAN JOURNAL OF OPTOMETRY *and* ARCHIVES *of* AMERICAN ACADEMY OF OPTOMETRY

EDITOR
CAREL C. KOCH

EDITORIAL COUNCIL
D. G. HUMMEL, Chairman
ROBERT E. BANNON
IRVING M. BORISH
RUDOLPH EHRENBERG
V. J. ELLERBROCK
RICHARD FEINBERG
ISIDORE FINKELSTEIN
HAROLD M. FISHER
EUGENE FREEMAN
GLENN A. FRY
HENRY W. HOFSTETTER
J. DONALD KRATZ
LEO F. MADIGAN
MEREDITH W. MORGAN, JR.
HAROLD SIMMERMAN
S. WINFIELD SMITH
WILLIAM O. VIVIAN

CONTENTS

ORIGINAL PAPERS

A Quantitative System of Dynamic Skiametry
Edwin Forbes Tait 113

Applications and Descriptions of a New Vertex Focometer
Harold C. Glover 130

Sex Differences in the Incidence of Various Grades of Myopia
Monroe J. Hirsch 135

Miscellaneous Optometric Data on Twins
Henry W. Hofstetter and David C. Rife 139

Ocular Manifestations of Avitaminosis
Morton K. Greenspoon 151

The Fitting of Highly Toric Corneae with Toric Corneal Contact Lenses
Max Schapero 157

EDITORIALS

New Developments in Undergraduate Education
Carel C. Koch 161

CURRENT COMMENTS 164-168

Published Monthly by the AMERICAN JOURNAL OF OPTOMETRY PUBLISHING ASSOCIATION
1502 Foshay Tower, 821 Marquette Ave., Minneapolis 2, Minn.

ANNUAL SUBSCRIPTION, UNITED STATES and CANADA $6.00. FOREIGN $6.50
Single copies, 60c

Entered as second-class matter, February 20, 1924, at the post office at Minneapolis 2, Minnesota, under the Act of March 3, 1879
Established 1924

Browcrest

now in MOCHA

The frame's the same . . . Continental's handsome, sturdy, well made Browcrest combination. The color is new.

Previously Browcrest came in Tortone only. Now you may get it in the rich and attractive Mocha shade.

In its test showings, Browcrest Mocha scored practically a perfect hit. Stocks are going into independent laboratories all over the country. You can start using it now.

Continental INDIANAPOLIS

AMERICAN ACADEMY OF OPTOMETRY

Dr. Meredith W. Morgan, Jr., *President*
Berkeley, California

Dr. John D. Perry, *Vice-President*
Winston-Salem, North Carolina

Dr. Carel C. Koch, *Secretary*
Minneapolis, Minnesota

EXECUTIVE COUNCIL

Dr. Meredith W. Morgan, Jr., *Chairman*
Berkeley, California
Dr. John D. Perry, *Vice-Chairman*
Winston-Salem, North Carolina
Dr. Carel C. Koch, *Secretary*
Minneapolis, Minnesota
Dr. Harold Simmerman, *Past President*
Wenonah, New Jersey
Dr. Lawrence Fitch
Philadelphia, Pennsylvania
Dr. Donald A. Springer
Anniston, Alabama
Dr. R. W. Tubesing
Richmond, Indiana
Dr. Ralph E. Wick
Rapid City, South Dakota

EX OFFICIO MEMBER

Dr. D. G. Hummel
Cleveland, Ohio

SECTIONS OF THE ACADEMY

SECTION ON ANISEIKONIA

Dr. Leo W. Madigan, *Chairman*
Boston, Mass.
Dr. Paul L. Connolly,
Detroit, Mich.
Dr. Benton Freeman
Allentown, Pa.
Dr. Bernard Mazow
Houston, Texas

CONTACT LENS SECTION

Dr. Isidore Finkelstein *Chairman*
New York, N. Y.
Dr. Jerome B. Conlogue
Peoria, Ill.
Dr. Eugene Freeman
Chicago, Ill.
Dr. Robert C. Graham
Pasadena, Calif.
Dr. John C. Neill
Philadelphia, Pa.
Dr. S. G. Weiss
Torrington, Conn.

SECTION ON PATHOLOGY

Dr. William O. Vivian *Chairman*
Media, Pa.
Dr. V. J. Ellerbrock
Columbus, Ohio
Dr. Monroe J. Hirsch
Los Angeles, Calif.
Dr. Rita Walsh
Bloomington, Ill.

SECTION ON OCCUPATIONAL OPTOMETRY

Dr. Richard Feinberg, *Chairman*
Chicago, Ill.

Dr. Richard M. Hall
Cleveland, Ohio
Dr. Henry B. Peters
Oakland, Calif.
Dr. Herman Sager
Lake Success, N. Y.
Dr. Edward Steinberg
New York, N. Y.
Cmdr. R. Rosswell Sullivan
U.S.N. Washington, D.C.
Dr. John R. Wittekind
Morrisville, Pa.

SECTION ON ORTHOPTICS

Dr. S. W. Smith, *Chairman*
Newark, Delaware

Dr. J. Donald Kratz
Souderton, Pa.
Dr. T. R. Murroughs
Chicago, Ill.
Dr. Max Schapero
Los Angeles, Calif.
Dr. William A. Sherard
Columbus, Ohio
Dr. Daniel Woolf
New York, N. Y.
Dr. John Zettel, Jr.
Cincinnati, Ohio

Office: American Academy of Optometry: 1502 Foshay Tower, Minneapolis 2, Minn.

The AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY serves as the official publication of the American Academy of Optometry. It is published monthly by the American Journal of Optometry Publishing Association under the editorial supervision of the American Academy of Optometry.

Publication Office: 1502 Foshay Tower, 821 Marquette Ave., Minneapolis 2, Minn.

Eyes Right for Daytime Wear

ONE PAIR OF GLASSES IS NOT ENOUGH—Patients recognize that glasses are *eyewear,* adornment for the most expressive facial feature—and that for differing activities, differing moods, expression of differing personality requires *different* eyewear styles. You perform a genuine service when you suggest to patients additional pairs of glasses for dress wear, for working hours, for leisure. In many cases, special vocational or avocational prescriptions are required—in most cases correction combined with glare protection—in all cases a stand-by pair for emergency use. For all patients *one pair of glasses is not enough.*

1853/1953 INTO A NEW CENTURY OF OPTICAL PROGRESS
BAUSCH & LOMB CENTENNIAL

BALRIM CITATION

- MORE PEOPLE WANT BALRIM THAN ANY OTHER FRAME
- AN *ORIGINAL* BAUSCH & LOMB DESIGN

r . . in Bausch & Lomb BALRIM

- BALRIM FRONT A COMPLETE GOLD-FILLED FRAME UNIT
- EXCLUSIVE B&L GRAYTON ROCKING PADS
- EYEWIRE GROOVES AUTOMATICALLY LINE UP SCIENTIFIC BRIDGE CONSTRUCTION
- L-O-N-G JOINT SCREW—EASY ASSEMBLY
- PROFILED, HAND-POLISHED ZYL—ACCURATE—BEAUTIFUL—DURABLE

BALRIM B-31

BAUSCH & LOMB

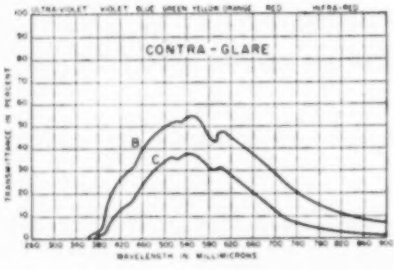
OPTICAL COMPANY ROCHESTER 2, N. Y.

Family Fun
in the Summer Sun!

PROTECT THEIR EYES WITH

Titmus CONTRA-GLARE Lenses

Absorbs ultra-violet and infra-red, reduces visible radiations and glare. A and B protect from average sunlight and other moderate sources of ultra-violet and infra-red. C for strong radiation, D only for most intense radiation.



VELVET-LITE

Absorbs ultra-violet, reduces excess visible radiations. A and B shades blend with the complexion, absorb ultra-violet and a portion of the visible blue. C and D reduce moderate to intense glare, retain relative natural colors.

CROOKES

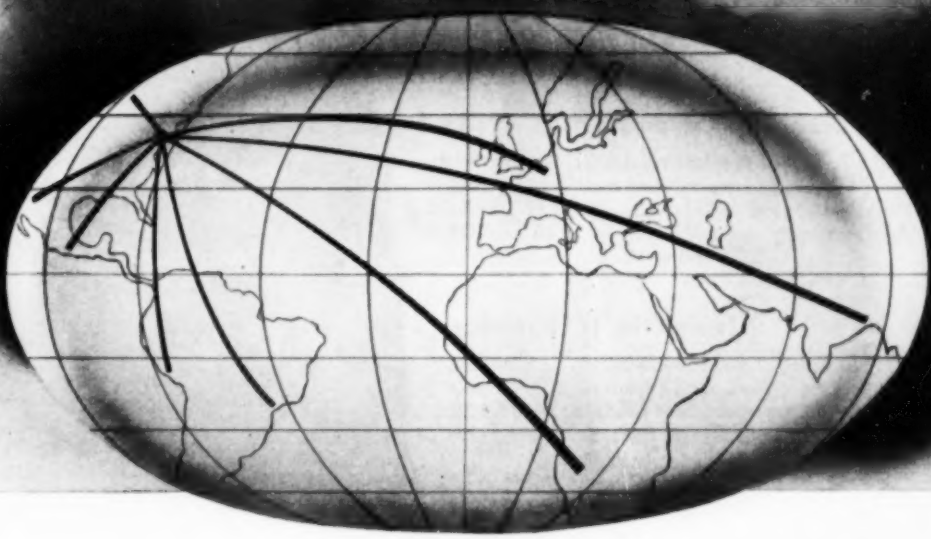
Absorbs ultra-violet, reduces excess visible radiation uniformly. Evenly reduces intensity of most of the visible spectrum, retaining relative color values. C is adequate for strong radiations, D only for most extreme cases.

Titmus

OPTICAL COMPANY, INC.

PETERSBURG, VIRGINIA

Here, There and Everywhere!



Today you'll find people wearing Art-Craft frames in nearly every port in the free world. Our foreign trade as well as our home markets have expanded in a most satisfying way. Proof that Art-Craft means quality in eyewear.

EXPORT OFFICE
39 State Street
Rochester 14, N. Y.

Over 100,000 sq. feet of floor space devoted to ART-CRAFT production.

ART-CRAFT *of Rochester*

OFFICES: NEW YORK
CHICAGO • PHILADELPHIA

Canadian Distributor: IMPERIAL OPTICAL CO., LTD., Toronto, Canada

NOW used I-Gard lenses can be

REPOLISHED

like new

scratches are quickly erased

all but deep-cut scratches, lines, markings, resulting from careless handling, are readily removed from both concave and convex surfaces by an entirely new method developed and perfected in the McLeod laboratories...

lens life is doubled

at *nominal cost* to wearers, the new McLeod repolishing technique can double and even treble the normal life of I-GARD lenses with the priceless protection that only I-GARDS can give.

Ask your distributor at once for full particulars

i-gard

Non-Shatterable
Fog-Resistant
Feather-Light
Water-White
Clearer Vision
More Becoming

i-gard Plastic Lenses

Distributed by—Blue Ridge Optical Co., Roanoke, Va. • Bradley Optical Co., Los Angeles, Cal. • Cannon Optical Co., Philadelphia, Pa. • Central Optical Co., Mobile, Ala. • Cummings-Robertson, Inc., Atlanta, Ga. • Dietz Optical Co., Fort Worth, Tex. • Fox Optical Co., Indianapolis, Ind. • Gregory Optical Co., Jackson, Mich. • Hawkeye Optical Co., Des Moines, Iowa • Homer Optical Co., Washington, D. C. • Knoxville Optical Dispensary, Knoxville, Tenn. • Lakeland Optical Co., Auburn, N. Y. • Muller-Bowman, Jackson, Tenn. • Onondaga Optical Co., Syracuse, N. Y. • Ostertag Optical Laboratories, Inc., Louisville, Ky. • Paramount Optical Laboratories, Portland, Ore. • Rooney Optical Co., Cleveland, Ohio • Sutherlin Optical Co., Kansas City, Mo. Winchester Optical Co., Horseheads, N. Y • York Optical Co., York, Pa.

an entirely new medium for providing Visual Protection

McLEOD OPTICAL COMPANY, INC.
357 Westminster Street, Providence, R. I.

ALWAYS HAS . . . ALWAYS WILL . . UNIVIS MAKES THE FINEST OPHTHALMIC PRODUCTS . . . ALWAYS HAS . . . ALWAYS WILL . . .
How many arm's length seeing jobs in this room?

If you think of it tonight, just look around your own living room. You'll be amazed to note how many "arm's length" jobs there are! Yet many bifocal wearers are receiving only *two-thirds* of the help they need. Are they "really living?"

On the other hand, for presbyopes fitted with Univis Continuous Vision Lenses, the problem doesn't even exist. For the lady of the house who does the work in the living room, and for the breadwinner who relaxes there, visual requirements are met comfortably and naturally with Univis CVs, thanks to the prescribing doctor or dispenser. More than a million people enjoy comfortable, full-field vision with the lenses now known as CVs. The Univis CVs you prescribe are insured and guaranteed through your Univis laboratory.

univis THE UNIVIS LENS COMPANY • Dayton 1, Ohio

UNIVIS CVs FOR ALL PRESBYOPIC NEEDS

Safety Expert Wears Therminon Lenses

Robert Hullihan, Director of Public Information for the Iowa Safety Council, has this to say about his Therminon Lenses: "I wear Therminon Lenses for one reason — to rest my eyes while I work. They do that job perfectly. But I discovered something more. Therminon Lenses soften the glare of headlights in night driving. They reduce that dangerous interval of blindness after bright light. Yet, there is no serious loss of 'visible light'—the light we need to see danger. Yes, I wear Therminon Lenses and I feel they give me extra comfort at work and extra safety on the highways."

Doctor, your patients may not be safety experts but they will appreciate the extra comfort and protection provided by genuine Therminon Lenses. You give your patients dividends when you prescribe Therminon, America's finest absorptive lenses.

COOL FILTERED LIGHT IS BEST FOR SIGHT

Therminon LENSES

THERMINON LENS CORPORATION, University at 63rd, Des Moines, Iowa

FRAME DISPENSING CABINETS for Optometric Offices

Cabinets in Natural, Platinum or Blond Oak; Walnut, Mahogany or Bleach Pine.

96 frame capacity.

Individual partitioned frame holders.

Velvet flocked drawer interior in Tan, Black or Blue.

Cabinet — 14½" high, 14½" wide and 16½" deep.

Satisfaction Guaranteed.

"from Builder to Buyer"

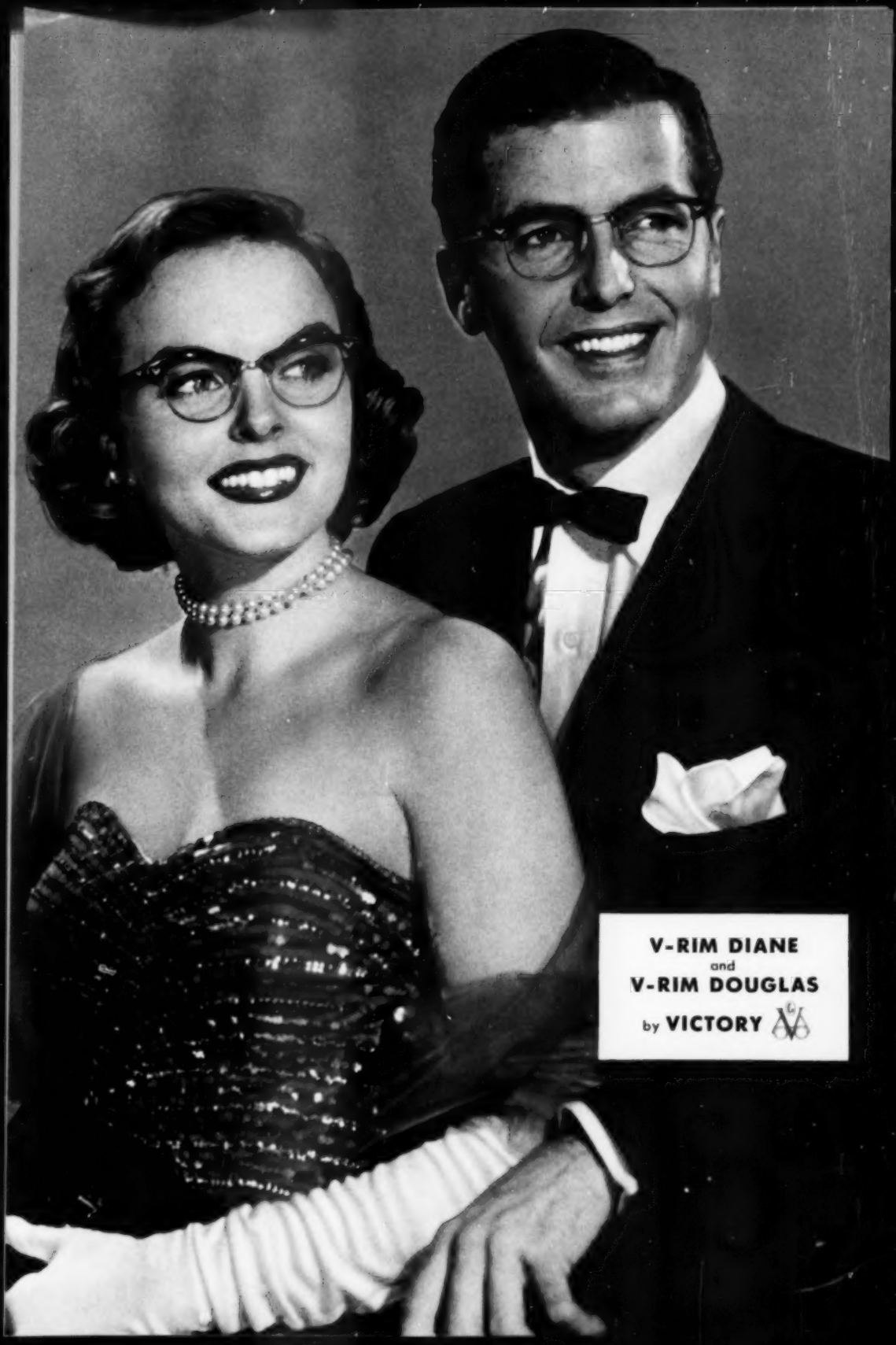
Order direct or write for descriptive literature.

Inconspicuous and Compact

$31.00
F.O.B. Minneapolis

KINEE WOODS

3986 Central Avenue
Minneapolis Minnesota


V-RIM DIANE
and
V-RIM DOUGLAS
by VICTORY

Spring is in the air!

...and in these gay and glorious Jersey Colors

Here's the true spirit of springtime... captured in this bouquet of popular Victory-styled frames... decked with the bright colors of beloved spring flowers. Perfect costume colors... to go places and do things... all spring and summer long!

V-Rim Diane
*203

Sweet Sixteen
*708

V-Set Diane
*205

5 Jersey colors

Sparkling combinations of Pearl Zyl flecked with either RED, BLUE, GREEN, BRONZE or YELLOW, and accented with silver lahn.

Available through your optical supplier

VICTORY OPTICAL MANUFACTURING COMPANY
NEWARK, N. J. · CHICAGO · LOS ANGELES · ATLANTA

Only You can inform Opinion Molders of Your Community with *Visual Digest*

—THE MAGAZINE WITH VISION

VISUAL DIGEST is planned and edited for public education about optometry. It lays the foundation in your community for the correct and truthful understanding of your profession.

Only you know who are the influential people in your community. Only you can give them this information they should have about optometry. Here is your personal opportunity to further the progress of your profession locally and at small cost. Enter now your subscriptions or bulk orders to VISUAL DIGEST for the opinion molders of your community.

Indicate on the order blank below the quantity you require and return by next mail.

Discounts apply to BULK orders only.

VISUAL DIGEST
Wilmac Building, Minneapolis, Minn.

I enclose check (or M.O.) to cover my order as checked below:

Single copies ..... 25c ( )
$1.00 order—net $1.00 (4 copies one issue) ( )
(4 consecutive copies) ( )
$10.00 order—
5% disc.—net $ 9.50 (40 copies) ( )
$20.00 order—
10% disc.—net $18.00 (80 copies) ( )

Name

Address

City State

The Investigation of the Variation and the Correlation of the Optical Elements of Human Eyes

by

Solve Stenstrom, M.D.

Translated from the original German by

Daniel Woolf, O.D.

School of Optometry, Columbia University, New York, New York

The anterior-posterior diameter of the eye and the role this plays in refractive errors. Including much other pertinent data. This translation reviewed and approved by Stenstrom.

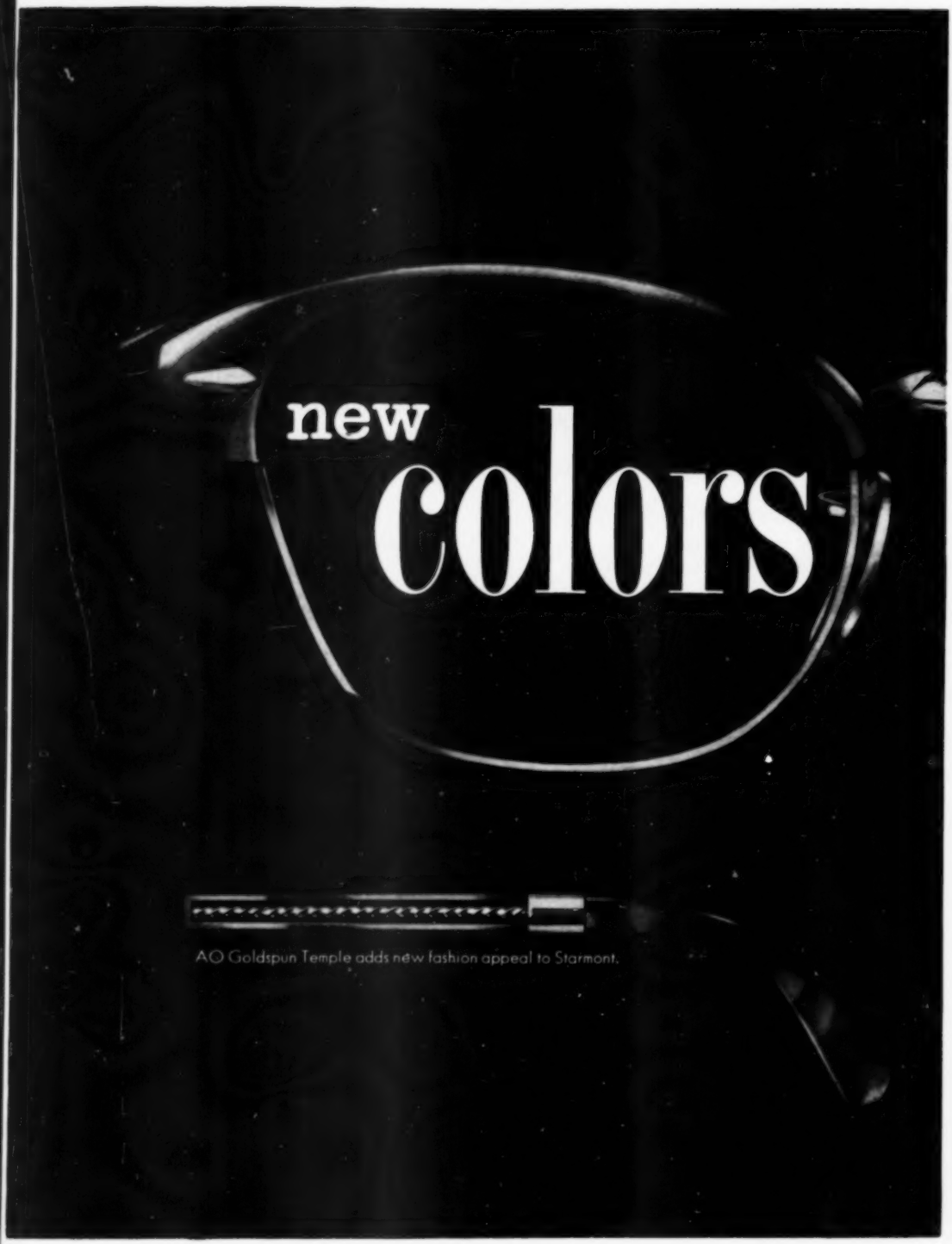
"His monumental monograph was published in German in 1946 and translated into English by D. Woolf under the auspices of the American Academy of Optometry." —A. Linksz, M.D., Physiology of the Eye, Vol. I, 1950.

This is a monograph that belongs in every optometrist's library. It is the most significant contribution to ophthalmic literature of the decade.

72 pages, 16 illustrations, board covers.
Price, postpaid, $1
Order by number, Monograph No. 58

AMERICAN ACADEMY OF OPTOMETRY

1502 Foshay Tower Minneapolis 2, Minn.



AO Goldspun Temple adds new fashion appeal to Starmont.

Four chic, modern decorative trims . . . Five Star, Lacebow, Prelude and Femme are now available for Starmont.

for AO Starmont

SABLE • BLUE MIST • CORDOVAN • ONYX • COPPER . . . five fashion-focused colors for the zyl sections of Starmont . . . offer you and your women patients a color choice to complement or tastefully match feminine accessory colorings! Each color is a solid, conservative in hue, and brilliantly enhanced by the incomparable special lustre of AO zylonite.

You can depend on AO Starmont for its Fashion Versatility and Ophthalmic Reliability. Ask your AO Representatives for samples—including all colors, trims and temples.

American Optical

FRAME DIVISION

Branch Laboratories
in Principal Cities
of Upper Midwest

Benson

OPTICAL COMPANY

MAIN OFFICE AND LABORATORY
MINNEAPOLIS, MINNESOTA

AMERICAN JOURNAL OF OPTOMETRY
and ARCHIVES *of*
AMERICAN ACADEMY OF OPTOMETRY

Vol. 30 March, 1953 No. 3

A QUANTITATIVE SYSTEM OF DYNAMIC SKIAMETRY*

Edwin Forbes Tait†
Norristown, Pennsylvania

INTRODUCTION

It is indeed an honor to be invited by the American Academy of Optometry to rewrite the paper on Dynamic Skiametry which I originally presented before the meeting in Chicago, on December 4th, 1928, and which was the result of some years of research in the Clinics of the Pennsylvania State College of Optometry.

In general, there has been little change of the concept then presented, as both the more recent research in the field and 24 years of extensive clinical experience tend to confirm the validity of the original investigations and conclusions.

Objective refraction of any accuracy is limited to the results obtained by two instruments, the ophthalmometer and the skiascope, and the latter only is useful in obtaining estimates of ametropia and lenticular changes. Procedures looking toward the objective analysis of refractive conditions at the near point, with the accommodation in use, can, therefore, under present conditions, be carried on only with a dynamic method of skiametry.

Psychologic judgment factors in any form of subjective test are always to be considered as presenting valid objections to efforts to develop such methods. It is quite apparent that when a considerable change is made in the retinal image by a correction of the refractive condition, the new perfect retinal image will be interpreted, due to training and habit, in terms of the old faulty image. Therefore, even when the proper correction is applied and a perfect retinal image produced, the individual may not have full visual effectivity until after the new correction is worn for a considerable period of time. Subjective correc-

*Read before the annual meeting of the American Academy of Optometry, Rochester, New York, December 7, 1952. For publication in the March, 1953, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

†Ophthalmologist. M.D., Ph.D.

tions, therefore, whether obtained by dynamic or static methods, by fogging or cycloplegia, are subject to inaccuracies.

My interest in the specific problems involved in the development of a usable and quantitative system of dynamic skiametry was aroused in 1921 as the result of the necessity of developing some definite procedure for use in routine clinical work. In an effort to reconcile the very marked variations in dynamic data found in individual cases, I undertook, the following year, a study of the whole problem by statistical methods, utilizing the very considerable amount of clinical material which I then had available. As the investigation progressed, its field widened, due both to the necessity of finding some method of estimating amounts of accommodation used during the dynamic fixation period and of constructing a skiascope to meet the requirements of such methods.

When, after 1901, dynamic skiametry became better known because of the pioneer work of Cross,[1] many refractionists attempted to use the method he suggested and interpret their findings according to the principles laid down by him. After considerable experimentation, general interest in the technique subsided because it was found that if the lens correction found by the method was prescribed, no patient could ever have clear distant vision and would, in other ways give evidence of overcorrection.

The basic principle of Cross' system of interpretation is that fixation at near stimulates the full amount of accommodation for the fixation distance. Thus, the basic refractive error would be equal to whatever correction was required to secure neutralization, for Cross believed that the convergent-accommodative relationship would surrender accommodation only to the point of relaxation of the accommodative excess, thereby maintaining the "three in one" ratio.

The judgment of many refractionists that this belief was not justified was upheld in 1917 by Sheard[2] when, as the result of a series of experiments, he demonstrated the presence of a "lag of accommodation behind convergence." The nature of this lag has been the subject of continued study.

This idea of flexibility of the accommodative-convergence relationship is not new, as Donders[3] recognized a certain independence in accommodation and convergence, as well as an interdependence.

Sheard[4] further showed that with the dynamic method, utilizing the modified skiascope developed by him, the average lag of accommodation behind convergence was about .75 D. for a group of individuals mostly of college age.

Bestor,[5] in a survey of a large number of cases, found the average

difference between the dynamic skiametric findings and the amount eventually accepted by the patient to be approximately 1.50 D. These patients were under 40 years of age and had no convergence anomalies or ciliary muscle hypertonus. Two factors were clearly understood by him: that the difference between his results and Sheard's was due to the technique employed, and that the 1.50 D. difference obtained only in individuals with good accommodative-convergent relationships.

Nott[6] also confirmed the findings of Sheard and Bestor as to the average value of the lag and developed a definite method of utilizing its value directly, the "observation behind fixation" method. In this procedure, the patient fixes upon a near point card with fixation characters arranged around a central aperture. The observer notes the reflex through the aperture from a point behind the fixation so calculated that the difference between the dioptric value of the two distances will be approximately .75 D. Nott[7] notes, however, that the technique is of little value in "spasm" cases, or where there is considerable insufficiency of accommodative-convergence.

Southall,[8] in a mathematical exposition of the subject, considered the lag as the manifestation of certain monochromatic aberrations of the eye, especially apparent during near fixation due to their increased dioptric value at that time.

Atkinson & Woll[9] agreed with Southall in the matter, but pointed out that regardless of the reason for its existence, the lag nevertheless must always be considered practically.

Ryer and Hotaling[10] combined an objective dynamic method with a cross-cylinder dynamic sujective procedure and considered that the method includes any lag value which may exist.

In a previous paper,[11] I suggested that the lag of accommodation was simply the manifest portion of the presbyopic curve relative to the point of fixation, and I have since had no good reason to modify this opinion. In any event, the amount of the lag at any age corresponds closely with the recession of the accommodative near point beyond the convergent near point, when both are related to fixation at one-third meter. All concerned, except Cross, agree that the lag is a very real clinical phenomenon and one which is quite constant in its relative value.

Sheard,[12] presenting the matter from a different point of view, that of the practical refractionist, considered the dynamic method as an objective procedure for determining the negative range of relative accommodation. He was supported in this viewpoint by Nott.[13] In the work reported in this paper, carrying on and amplifying this con-

cept of negative relative accommodation, I consider that the lag of accommodation and the negative relative accommodation are manifestations of the same process, viz., the relaxation of the ciliary muscle during accommodation permitted by the presence of sufficient plus lens power to replace as much accommodation as can be relaxed with a particular fixation convergence.

Contributions to the subject since this paper was originally presented do not suggest any significant departure from this viewpoint.

Pascal,[14] in 1930, stressed the presence of an area rather than a point of neutralization in a dynamic skiametric procedure, designating the point representing the greatest convex or least concave lens power as the "high-neutral" and the converse as the "low-neutral."

Dobson[15] summarized previous work and presented a method of her own in which not only heterophoria at the near point is considered as a factor in interpretation, but also the amount of lateral fusional vergence, the latter to determine the amount of prism base-in power to incorporate into the lens formula under certain conditions.

Turville,[16] in 1933, summarized previous work, Rosen,[17] in 1936, discussed the characteristics of the light reflex in skiametry, and Taylor,[18] in 1945, discussed the relationship of the binocular reflexes to the method.

In the methods thus far presented, there has been—

1. An agreement, except for the original work of Cross, that the lag of accommodation behind convergence affected the amount of spherical lens power found at the near point: in hyperopia increasing the convex lens power over the static results and decreasing the concave lens value in myopia.

2. An agreement that this value varies in individual cases, especially those presenting convergence insufficiency, thus preventing any fixed deductions from the gross dynamic lens findings.

3. A disagreement as to the actual value of the lag, the estimates ranging from a non-recognition of its existence (Cross) to an average of 1.50 D. (Bestor), probably due to non-corresponding or incomplete procedures and failure to take into consideration all near point factors.

4. A disagreement as to the physiologic and psychologic bases of the lag.

There was, therefore, in order to establish a practical system of dynamic skiametry, need for—

(a) A quantitative analysis of the following factors present at the near point, together with a method of computation applicable to the individual case:

1. Lag of accommodation behind convergence.
2. Total negative relative accommodation.
3. Convergent-accommodation.
4. Ciliary muscle tonus.

(b) A definite objective method to ascertain the amount of accommodation retained during the period of the test, so that due allowance can be made for it.

(c) An adequate skiascope developed for use with such a method.

(d) A simple quantitative system of application.

PLAN OF THE ORIGINAL STUDY

Having in mind, as a whole, the problems set forth, I attempted to find a practical solution so that an acceptable dynamic system, capable of being applied clinically, could be developed.

The study was divided into four parts, as follows:

Part I. Lag of Accommodation Studies, Development of the Dynamic Fogging Technique, and Recognition of the Neutralization Area.

Part II. Accommodative-convergence and Convergence-accommodation Correlation with Extension of the Conception of Physiologic Exophoria.

Part III. Development of Skiascope Adapted to the Modified Technique.

Part IV. The Present Quantitative System, Its Technique, Interpretation and Application.

I. LAG OF ACCOMMODATION STUDIES, DEVELOPMENT OF THE DYNAMIC FOGGING TECHNIQUE, AND RECOGNITION OF THE NEUTRALIZATION AREA.

DISCUSSION

When this early part of the study was begun in 1922, there was no idea in my mind that it would develop into such a long-continued systematic investigation. Therefore, although some 700 cases were tabulated, there was not the close attention to accuracy striven for in the later phases of the work.

With the work of Sheard as a basis, and using his plan of fixation on the plane of the skiascope, building up lens power from zero and stopping at the point of very rapid "with" movement, some very interesting data were obtained. During the latter part of this initial investigation, each case, amounting in all to some 300, was also subjected to a variation in the above procedure by working out the dynamic finding after the subject had been made considerably myopic for the fixing

distance by excess plus lens power. In this portion of the work, the difference between the dynamic and static skiametric findings, provided the latter corresponded closely with the subjective, was considered as the lag of accommodation.

PROCEDURE

During the course of a routine refraction, the following findings were noted on the clinic record sheet, and afterward copied carefully for statistical analysis:

1. Age.
2. Dynamic Skiametry (at 1/3 meter)
   (a) Sheard's method
   (b) Fogging method (in later cases)
3. Static Skiametry.
4. Subjective.
5. Apparent lag of Accommodation
   (Difference between 2 and 3)

Each case was refracted either by myself, or by either of two assistants who were carefully trained in the methods employed.

In order that the effect of a considerably diminished accommodative amplitude might be eliminated, no cases of over 40 years of age were included, nor were cases with more than 4Δ of either esophoria or exophoria at distance with the subjective correction. Also excluded were cases with apparent ciliary muscle hypertonus and those where the cylindrical corrections differed in the various tests.

The skiascopes used in this part of the work were plain luminous instruments with paper clips holding the fixation charts, as suggested by Sheard.

RESULTS

Table I gives the data obtained in 10 of the later cases, showing the method of recording and the statistical analysis of the complete data.

It will be noted that the average value of the lag of accommodation which I found by Sheard's method is somewhat greater than that found by him. This may be explained by the much wider age distribution in this group, as later work has shown that the lag value is apparently a function of age. In general, however, and especially among the younger (20 to 25 years) group, Sheard's values were confirmed.

Some difficulty was encountered in many cases in recognizing the point of neutralization, as often additional convex lens power did not result in the expected reversal, but caused no apparent change. It was this fact which led to the introduction of the "fogging" technique in an attempt to secure as much accommodative relaxation as possible and

TABLE I
COMPARATIVE DATA FROM PART I.
Ten typical cases from the 300 subjected to both the Sheard and the "fogging" methods.

No.	Age	Dynamic Skiametry Sheard	Dynamic Skiametry Fogging	Static Skiametry	Subjective	Apparent Lag. Sheard	Apparent Lag. Fogging
1	39	O. U. + 2.50	O. U. + 3.25	O. U. + 1.25	O. U. + 1.25	1.25	2.00
2	21	O. D. + .75	O. D. + 1.50	O. D. — .50	O. D. — .75	1.50	2.25
		O. S. — .50	O. S. + .25	O. S. — 1.75	O. S. — 2.00		
3	33	O. D. + 2.00	O. D. + 3.25	O. D. + 1.00	O. D. + 1.00	1.00	2.25
		O. S. + 2.50	O. S. + 3.75	O. S. + 1.50	O. S. + 1.50		
4	20	O. D. + 2.00	O. D. + 3.00	O. D. + 1.50	O. D. + 1.50	.50	1.50
		O. S. + 1.75	O. S. + 2.75	O. S. + 1.25	O. S. + 1.25		
5	18	O. U. + 2.25	O. U. + 3.75	O. U. + 1.50	O. U. + 1.50	.75	2.25
6	29	O. U. + 3.00	O. U. + 3.50	O. U. + .75	O. U. + .50	2.50	3.00
7	22	O. D. + 5.75	O. D. + 6.25	O. D. + 3.25	O. D. + 3.25	2.50	3.00
		O. S. + 4.50	O. S. + 5.00	O. S. + 2.00	O. S. + 2.00		
8	25	O. D. — 1.50	O. D. + .50	O. D. — 1.75	O. D. — 2.25	.75	2.75
		O. S. — 4.50	O. S. — 2.50	O. S. — 4.75	O. S. — 5.25		
9	30	O. U. + 2.25	O. U. + 3.75	O. U. + 1.25	O. U. + 1.25	1.00	2.50
10	6	O. U. + 2.00	O. U. + 3.00	O. U. + 1.50	O. U. + 1.50	.50	2.50

NOTE: Spherical values only noted. Cylindrical values, if present, coincided in all four tests, and are eliminated in the interest of simplicity.

a possible fixed point of neutralization. It was found, however, that in many cases *no definite point of neutralization could be found*, and eventually there came to be an appreciation of the fact that in most dynamic skiametry procedures there is an area rather than a point of neutralization. The high and low points of this area were finally determined, for practical purposes, as the point of extremely rapid "against" movement when "fogging" down, and the point of extremely rapid "with" movement when building up from zero, in the case of a hyperope, and, of course, the opposite in the case of a myope.

It was found that when the lag value by Sheard's method was high, there was usually a smaller neutralization area than when it was low, and in a few cases the high and low points coincided when the apparent lag value was a total of 3 diopters. In these latter cases, no accommodation was in use at the end of the dynamic procedure, and thus the results obtained corresponded to those of a static test at the same distance. In general, the difference between the static results and those obtained by the fogging method were very close to the 1.50 D. average difference found by Bestor. It is apparent that Bestor was not satisfied with an apparent neutralization of the shadow movement, but continued to add plus power until he obtained a definite reversal of movement, thus continuing through the neutralization area to the high point.

SUMMARY

1. The average lag value for the whole group, 1.12 D., was considerably higher than that obtained by Sheard.

2. The lag value for the 20 to 25 years old group, .75 D., confirmed rather closely that found by Sheard, and if the few excessively high and total lag cases were eliminated from consideration, the value would coincide with his findings.

3. In all except the total lag cases, there was a difference in the results obtained by the "fogging" and the "building-up" dynamic systems, more plus being accepted by the fogging technique. There is, therefore, an area of neutralization having a high and low point instead of a definite single point of reversal.

4. With the fogging technique, there was an average difference between dynamic and static results of 1.75 D. Eliminating the high lag cases (over 1.50 D.) found by the Sheard system, the average value of this difference was identical with the 1.50 D. found by Bestor.

5. No apparent correlation was found between the lag of accommodation and the subjective negative relative accommodation.

Between the time this study was completed and the present, the results obtained in the several thousand cases reported in Parts II and III of this paper have practically confirmed these original findings, although the analysis has not been repeated, due to the abandonment of the "building-up" method except in presbyopic cases. Table 2 summarizes in tabular form the results of Part I.

TABLE II. STATISTICAL DATA. PART I.

Total Number of Cases	712
Number subjected to "Fogging" Procedure	330
Average value of lag of accommodation (all cases)	1.12 D.
Average value of lag of accommodation (20 to 25 years)	.75 D.
Average difference in "Fogging" dynamic and static	1.75 D.

II. ACCOMMODATIVE-CONVERGENCE AND CONVERGENT-ACCOMMODATION CORRELATION WITH EXTENSIONS OF THE CONCEPT OF PHYSIOLOGIC EXOPHORIA.

In analyzing some of the total and high lag of accommodation cases presented in Part I, I was struck with the apparent relationship existing between increased exophoria at near and the increase in lag value. Usually, when there was a considerable amount of exophoria at near, there would be a relatively high lag, and, in the latter part of the work, when the one factor was found to be high, the other was expected to be and mostly was high.

Working on the theory thus suggested, that the accommodation in

use during the dynamic test could be estimated by the amount of the accommodative-convergence present under the same conditions, in 1924 I began a systematic investigation of the matter. Nothing in the literature could be found to support this view and apparently no systematic work had ever been done, so that the investigative methods and their interpretation had to be developed.

As experience with Part I had shown, a nearer approach to the final correction could be obtained in most cases by the "fogging" dynamic system, with its basic deduction of 1.50 D., than with Sheard's method. This method was therefore used in all cases.

Each case under 40 years of age was subjected, during the course of routine refraction, to a careful fogging dynamic procedure at 1/3 meter, together with a careful static skiascopic procedure, and the dioptric difference between the two noted. With the static result in place, the distance and near heterophorias were ascertained, the pupillary distance noted, and the amount of physiologic exophoria and accommodative-convergence computed. The measurement of the lateral heterophoria was done chiefly by the prismatic dissociation method, using a 6Δ prism base-down over the right eye to produce diplopia, with a rotary prism over the left for the base-in and base-out power. With the latter a vertical coincidence of the object was obtained and the amount read off on the rotary prism scale. The usual object for distance was the 20/200 letter of the test chart, and the near object was a 3 mm. letter E on the usual type of phorometer card set at the 1/3 meter position on the phorometer rod.

The difference between the dynamic and static findings was considered to be negative relative accommodation and was graphically compared with the accommodative-convergence.

RESULTS

The results of this comparison in 1,100 cases are shown graphically as a distribution curve in Figure 1. All types of cases were used except those with a very manifest ciliary muscle hypertonus or with physiologic esophoria.

An analysis of the curve shows practically no decrease in the dynamic-static difference, with an increase in accommodative-convergence beyond 12Δ. Maddox[19] showed, many years ago, that 4Δ to 6Δ of exophoria at near, which means a deficiency of accommodative-convergence to that extent, was to be expected in the normal case, and Sheard,[20] at a later date, verified the observation.

An accommodative-convergence of over 12Δ, therefore, does not indicate that more than 1.50 D. of convergent or fixation accommoda-

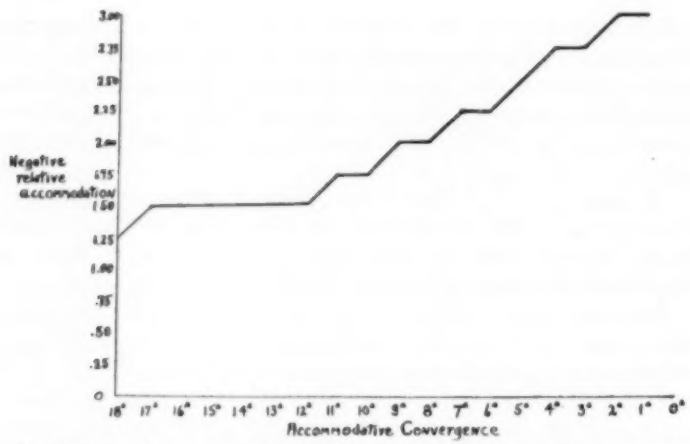


Fig. 1. Average values of negative relative accommodation for various amounts of accommodative-convergence in 1,100 cases under age 40. To nearest 0.25 D. and 1Δ.

tion is in use. As the accommodative-convergence value falls below 12Δ, however, the dioptric difference increases fairly regularly until the limit of three diopters is reached.

Figure 2 illustrates the distribution of all cases of 12Δ of accommodation-convergence with respect to their dynamic-static differences. The

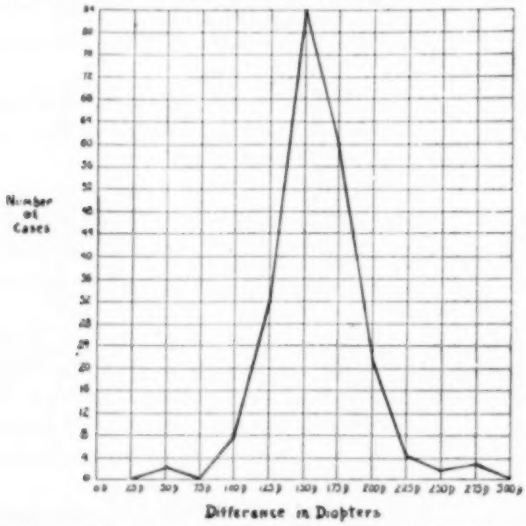


Fig. 2. Distribution with respect to dynamic-static difference of 219 cases with 12Δ of accommodative-convergence.

exceedingly sharp and high curve found suggests that we are here dealing with a definite physiologic factor.

In the process of tabulating the results, the tedious labor of calculating graphically the value of the accommodative-convergence in each case was simplified by the development of the following formula, which is fundamentally accurate and always applicable. As its rationale is quite apparent, it will not be discussed at length in this paper.

(1) $E_n - E_d = E_p$

(2) $AC = TC - E_p$

TC = Total convergence in prism diopters from parallelism to the near point.

E_d = Esophoria or exophoria at distance.

E_n = Esophoria or exophoria at near (1/3 meter).

E_p = Physiologic exophoria or esophoria.

AC = Accommodative-convergence.

For purposes of calculation, esophoria is considered a negative value and exophoria a positive.

An analysis of the age groups showed that there were more cases showing a high accommodative-convergence than otherwise, without regard to age. Apparently age affects but slightly the accommodative-convergence reflex. Practically every case showed an accommodative relaxation during the dynamic test of at least 1.25 D. Complete relaxation of accommodation was had in very few cases, and it was noted that in those cases little accommodation-convergence was present. Without question, the total relaxation in the other cases was prevented by the accommodation which was present because of the innervation furnished by the convergence-accommodation reflex. In these cases, the accommodative-convergence present was comparatively proportional to the convergent-accommodation, as shown in Figure 1.

In 1933, I published the results of a careful investigation of the relationship of the complex reflex systems in accommodation and convergence.[21] This study confirmed in a very positive way the impressions mentioned in the preceding paragraph, showing that there was a very definite set of reciprocal reflexes in the accommodation-convergence relations. In fact, the actual coefficient of correlation between accommodative-convergence and convergence-accommodation was $+0.73 \pm .014$.

Figure 3 shows the actual distribution of 500 subjects reported in the 1933 paper.

SUMMARY

1. There is a close relationship between the amount of accommodative-convergence present during a given set of circumstances and the

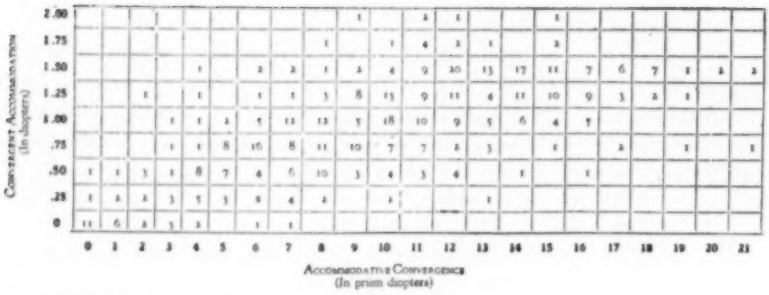


Fig. 3. Distribution of 500 cases, ages 10-40 years.

convergent-accommodation present under comparable conditions.

The major difficulty in the interpretation of dynamic skiametric findings is in the determination of the amount of accommodation in use during the test. This cannot be measured directly, but apparently it can be estimated indirectly with usable accuracy by ascertaining the accommodative-convergence to which it is ordinarily relatively proportional. The accommodative-convergence and the convergence-accommodation seem to be two aspects of the same association reflex.

2. The need for a simple mathematical determination of the amount of accommodative-convergence in use during a given fixation, and with a given spherical correction, is met by the development of the simple formula as presented above.

III. DEVELOPMENT OF A SKIASCOPE ADAPTED TO THE MODIFIED TECHNIQUE.

During the course of the work reported in Parts I and II, much trouble was experienced in finding a type of instrument which would permit binocular fixation on the part of the patient and yet not have the fixation chart so far from the mirror as to produce an astigmatic aberration. Most of the earlier work in Part II was done with the then commercially available skiascopes, none of which was entirely satisfactory, so that some attention was given to the development of a suitable instrument.

The requirements were as follows:

(a) An illumination giving a small spot of light at 1/3 meter and preferably of the filament source type. The so-called diffused illumination instruments were not desirable, as they had to be rotated too far to see the movement. With the filament type, the slight variations in the central pupillary area could be observed.

(b) Two fixation charts, one on either side of the instrument, so arranged as to be illuminated at will, and at such a distance as to minimize the possibility of an astigmatic aberration because of the angle between the visual axis and the line of observation. Each fixation chart to be arranged so that it could be seen clearly by both eyes simultaneously because binocular fixation is required in order that convergence may be controlled.

Two charts, one on each side and on the plane of the skiascope, seemed to be indicated because a considerable number of individuals had trouble retaining binocular vision when the charts were placed above or below the mirror. The distance between the center of the charts and the peep-hole in the mirror was set finally at 25 mm., which was the most comfortable and efficient distance for the greatest number of the group tested. Some individuals could fix acceptably with a separation distance of 15 mm., but the 25 mm. distance included practically all and at the same time gave a relatively small angle of fixation. Figure 4 shows two

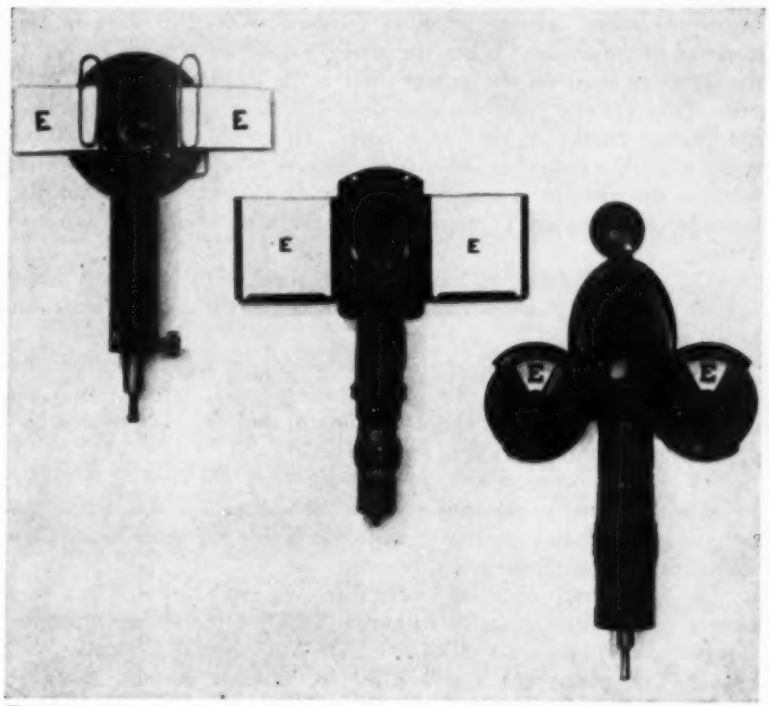


Fig. 4.

of the experimental instruments used successively during the experiments, and the final model.

IV. THE PRESENT QUANTITATIVE SYSTEM, ITS TECHNIQUE, INTERPRETATION AND APPLICATION.

As a result of the work reported in the foregoing parts of this paper, a definite system for obtaining and interpreting dynamic skiascopic data was evolved and used with clinical patients beginning in 1926, and has been constantly in use since that time. Some 2,500 cases, selected at random from the very considerable number thus refracted, were analyzed carefully in the original paper.

The present system is as follows:

1. Sufficient plus lens value is placed before the patient to make him quite myopic for the 1/3 meter fixation.

2. With the patient fixing with both eyes on one chart of the modified skiascope at a time, the plus value is gradually reduced until the "high point" of neutralization is reached. If reached in one meridian before the other, concave cylinders are used with their axes in the meridian first corrected. When the patient's right eye is being refracted, the skiascope chart on the patient's left is the fixation chart, and vice versa. The eye not being refracted should be kept slightly myopic for the fixation point. As the "high point" represents the neutralization status when the patient is about 0.25 diopters myopic for the point of fixation, this amount in convex lens value should be deducted from the lenses before the patient's eyes, and the remainder recorded as the dynamic finding.

3. From the dioptric values thus obtained, if the patient is under age 40, an arbitrary subtraction of +1.50 diopters is made to secure an initial approximation.

4. With this initial approximate correction in place before the patient, the distance and near (1/3 meter) lateral heterophorias are obtained, the physiologic exophoria found, and the accommodative-convergence present under the conditions calculated.

5. The accommodative-convergence thus obtained is assumed to be proportional to the convergent-accommodation in use during the test and is then compared with the values in Table 3 in order to ascertain if the initial approximation can be made.

6. The result obtained by the foregoing procedure will be a very close approximation (usually within 0.25 D.) of the ultimate distance lens correction in the great majority of non-presbyopic individuals.

7. In presbyopia, the system, for obvious reasons, must be modified as follows:

(a) If the "fogging" system is used, the initial deduction, instead of being 1.50 D., is that indicated by the total negative relative value for the age.

(b) For patients over 50 years of age, it is usually better to use Sheard's non-fogging method, beginning with a low convex lens in hyperopia, or a higher concave lens in myopia, and stopping at the low point of neutralization. This represents the actual correction at the point of fixation, and if the normal addition for the age is subtracted, the result will be a quite accurate approximation of the distance refraction. As the usual table of presbyopia additions is calculated for a comfortable near point of about 16 inches, the test should be made at that distance.

In the 2,500 cases cited in the original paper, ranging from 10 to 65 years of age, the final comfortable correction was approximated closely by the dynamic analysis in about 85 per cent. Of the others, some presented abnormal heterophoric conditions, others failed to report as to the comfort obtained, and in other cases where ciliary hypertonus was present, the patients would not submit to the necessary treatment. On the whole, however, the results indicate the applicability of the system, especially in those cases where relaxation methods have little effect, as in ciliary muscle hypertonus, in partially amblyopic eyes, in the examination of children, or in patients who are mentally subnormal.

In order to obtain some idea of the values of the near point factors always present in the normal accommodative-convergent case, an analysis of the total negative relative accommodation was made in 1,745 of the original 2,500 cases which showed an accommodative-convergence of 10Δ or more.

Figure 5 shows the average values of the total negative relative accommodation according to age, together with the lag of accommodation, as shown by Sheard's method. It will be noted that these curves, representing the mean value of the distribution, are quite regular, in fact too much so for anything but a physiologic relationship. Apparently these negative values are the result of physiologic processes, such as presbyopic development, which are direct functions of age. The decrease in tonic accommodation with age, because of increased sclerosis of the crystalline lens, is also shown in Figure 5.

It is apparent that as accommodative "cramp," no matter what its innervational source, is nevertheless accommodation, the accommodation used in near point fixation will include the hypertonic accommodation if the fixation point is sufficiently close. Thus, if the convergent-accommodation in play during the dynamic procedure is at its maximum of 1.50 D., hypertonic accommodation of a value not to exceed that

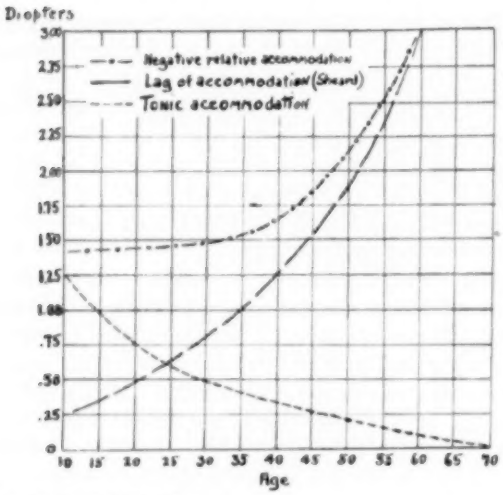


Fig. 5. Average values of 3 functions.

amount can be included by it and the basic correction, as found by the dynamic interpretation, will represent the comfortable correction when the hypertonus is relaxed. Thus the method affords a ready means of measuring latent hyperopia resulting from ciliary muscle hypertonus.

In order to provide for cases with apparently more than 1.50 D. of hypertonic accommodation, a special allowance in Table 3 is shown worked out for data obtained at 1/5 meter. This distance, with its maximum convergent-accommodation of 2.00 D. will include practically all cases presenting a ciliary muscle hypertonus. In a recent book,[22] I have described in minute detail the actual maneuvers employed in the technique of the method.

TABLE III. ALLOWANCES IN DYNAMIC SKIAMETRY

Physiologic Exophoria	Accommodative-Convergence	Allowance 1/3 Meter	Allowance 1/5 Meter
0 — 6	12 — 18	1.50 D.	2.00 D.
8	10	1.75 D.	2.50 D.
10	8	2.00 D.	3.00 D.
12	6	2.25 D.	3.50 D.
14	4	2.50 D.	4.00 D.
16	2	2.75 D.	4.50 D.
18	0	3.00 D.	5.00 D.

SUMMARY AND CONCLUSIONS

The results of the studies reported in this paper lead to the following conclusions:

1. That there is a definite negative relative range of accommodation, or lag of accommodation, for any given fixation, as found by Sheard.

2. That this negative range has a different value according to the technique used. Its greatest expression in objective work can be obtained by the use of the "fogging" technique.

3. That the negative range of accommodation is prevented from being total for fixation distance by some positive accommodation stimulated by the convergence for the point of fixation.

4. That this positive relative accommodation or convergence-accommodation can be estimated by the accommodative-convergence found under corresponding conditions. This relationship apparently is the manifestation of a reciprocal reflex system which will operate either way under suitable conditions.

5. That a quantitative system of dynamic skiametry based upon these concepts is thoroughly practical in the great majority of cases, and even where not immediately applicable, suggests the proper diagnosis.

REFERENCES

[1]Cross, A. J., "Dynamic Skiametry in Theory and Practice," New York, 1911.
[2]Sheard, C., "Dynamic Skiametry," Cleveland Press, Chicago, 1920, p. 18.
[3]Donders, F. C., "Accommodation and Refraction of the Eyes," Sydenham Soc., London, 1864, p. 110.
[4]Opus, cit., p. 18.
[5]Bestor, H., "The Interpretation of Dynamic Skiametry Findings," Amer. Jour. Physiol. Opt., Vol. I, No. 3, 1920, p. 223.
[6]Nott, I. S., "Dynamic Skiametry, Accommodation and Convergence," Amer. Jour. Physiol. Opt., Vol. VI., No. 4, 1925, pp. 496-497.
[7]Nott, I. S., "Dynamic Skiametry, Accommodation and Convergence," Amer. Jour. Physiol. Opt., Vol. VII., No. 3, 1926, pp. 366-374.
[8]Southall, J. P. C., "The Optical Principles of Skiametry," Jour. Opt. Soc., Vol. XIII., No. 3, 1926.
[9]Atkinson, T. G. and Woll, F. A., "Dynamic Skiametry," The Prof. Press, Inc., Chicago, 1928, p. 64.
[10]Ryer, E. LeR. and Hotaling, E. E., "Objective Dynamic Retinscopy Combined with Subjective Cross-Cylinder Control," Opt. Jour., Vol. LIX., No. 15, pp. 21-23.
[11]Tait, E. F., "A System of Near Point Tests," Opt. Jour. & Rev., Vol. LIII., No. 14, 1924, pp. 20-27.
[12]Sheard, C., "Dynamic Ocular Tests," Columbus, 1917, p. 128.
[13]Opus, cit. note 6, p. 496.
[14]Pascal, J. I., "Modern Retinoscopy," Hatton, London, 1930.
[15]Dobson, M., "Dynamic Retinoscopy," Oxford Univ. Press, London, 1931.
[16]Turville, A. E., "Retinoscopy," Jas. Hedderwick & Sons, Glasgow, 1933.
[17]Rosen, J., "Source of Reflex in Retinoscopy," Brit. Jour. Physiol. Opt., April, 1936.
[18]Taylor, S., "Dynamic Retinoscopy and the Binocular Reflexes," J. H. Taylor, Ltd., London, 1945.
[19]Maddox, E. E., "The Ocular Muscles," Keystone Pub. Co., Phila., 1907, p. 227.
[20]Opus, cit., note 12, p. 58.
[21]Tait, E. F., "A Reciprocal Reflex System in the Accommodation-Convergence Relationships," Amer. Jour. Psych., Vol. XLV., April, 1933.
[22]Tait, E. F., "Textbook of Refraction," Saunders Co., Philadelphia, 1951, Chaps. XXIII. and XXVIII.

APPLICATIONS AND DESCRIPTION OF A NEW VERTEX FOCOMETER*

Harold C. Glover†
Aero Medical Laboratory
Wright Air Development Center
Wright-Patterson Air Force Base, Ohio

The vertex focometer described in this paper was developed to test and evaluate the optical quality of several new visors which recently have gained Air Force usage. Commercially available instruments are not adequate to accurately measure the optical quality nor physically accommodate these large visors. A brief description of these visors should provide a better understanding of the optical problems involved. The windblast visor (Figure 4) was designed to prevent the helmet and

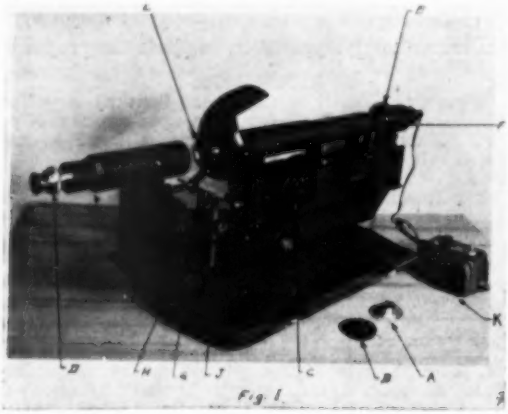


Fig. 1

oxygen mask from being torn off by windblast during high speed seat ejection bailouts. A secondary purpose is to provide glare protection to the wearer: this is accomplished by making the visor neutral in color with a 15% transmittance. The surfaces of this visor are concentric and spherical in curvature. The high altitude helmet visor may be one of three different shapes. The K-1 helmet (Figure 5) which is the standard for high altitude flight has two visor shapes, the compound curved shape is regularly used, but an alternate "V" shaped visor will be employed by

*Read before the annual meeting of the American Academy of Optometry, Section on Occupational Optometry, Rochester, New York, December 8, 1952. For publication in the March, 1953, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.
†Optometrist.

personnel using optical bomb, gun and sextant sights. The purpose of the "V" visor is to permit the wearer to position his eye at the designed eye relief position of these sights. The compound curved visor has a large eye relief which prevents the wearer from obtaining the full field

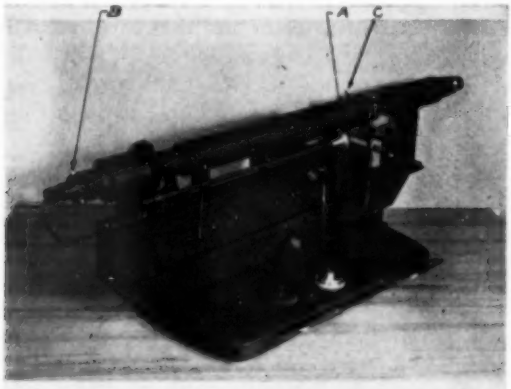


Fig. 2

of view through the above mentioned optical sights thus necessitating the use of a "V" shaped visor which provides better eye relief conditions. A new altitude helmet under development has a cylindrically shaped visor. These three altitude helmet visors and the windblast visor are made of acrylic plastic material.

All of these visors are intended for usage under extreme high speed flight conditions where the very best optical quality is demanded. Visual inspection of these visors reveals that the optical quality is poor in all but the windblast visor. Due to the more urgent need for the windblast visor, it was developed prior to the other visors which are now in a state of development. Good optical quality visors for the altitude helmets are badly needed and the Air Force has initiated the development of these visors. When the visor surfaces are concentric all visor types described above have inherent optical defects of either refractive power, prismatic effect or both. As an example, the compound curved visor (Figure 5) as used on the K-1 altitude helmet has an inherent cylindrical power of approximately 0.25 diopters when concentric surfaces are utilized. This is due to the different radii of curvature in the vertical and horizontal meridians. Also, the electrical wiring needed for defrosting and defogging the visor induces considerable visual disturbance. It is possible to reduce the refractive power of the visor by the utilization of

non-concentric surfaces. However, no substitute for the wired heating element has proven effective.

With the development of these plastic visors, the Air Force needed an accurate instrument to measure small amounts of refractive and prismatic power. The visors are positioned a much greater distance from the eyes than the spectacle lens plane and thus small amounts of power are more effective in altering the visual condition. This vertex focometer was developed by the American Optical Company to meet Air Force requirements. The instrument (Figures 1 and 2) is a refinement of the

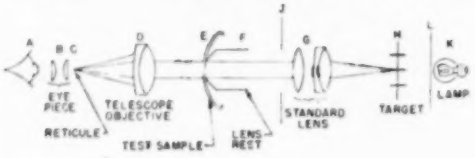


FIG. 3. SCHEMATIC DRAWING OF THE OPTICAL SYSTEM OF THE VERTEX FOCOMETER

A.O. lensometer design, and it is operated in the same manner. An increased sensitivity has been obtained by using a standard lens with a large aperture and large focal length, and a telescope system with a correspondingly large objective lens. A schematic representation of the optical system is found in Figure 3.

The requirements, other than those of accuracy which this instrument was designed to meet, were that it should accommodate large size optical sections, specifically, that the instrumental optical axis clear the frame by a minimum of six inches. Also, the instrument was to be portable and mounted to the stand so as to provide a height adjustment. Further, that the instrument be equipped with a spring tensioned lens holder (Figure 1L) adequate to keep in place optical sections the size of the visors discussed above.

The focometer is calibrated to provide for refractive power determinations to within 0.01 diopter of spherical and compound curved test sections. The range within which refractive power measurements are possible, as indicated on the graduated power wheel (Figure 1C), is from —0.30 to +0.30 diopter. The sensitivity of the instrument is such that it is easy to repeat settings to a high degree of accuracy usually to within 0.005 diopter when the test section is of a uniform nature. The prismatic power range of this instrument is from zero to 0.5 prism diopter. Prismatic power and the location of the prism base are measured by the eyepiece reticle. Calibration of the reticle is such that concentric black rings

are spaced at intervals corresponding to tenths of a prism diopter. Prism measurements may be estimated to within 0.03 prism diopter.

A variable intensity incandescent lamp (General Electric Catalogue No. 1394) with a yellow filter illuminates the background target. A transformer (Figure 1K) permits control of the light source so that materials with transmission values ranging from 5% to 95% may be

Fig. 4

tested. The instrument was calibrated using a sodium laboratory arc lamp. The use of a yellow filter instead of the usual green filter in lens measuring instruments has the advantage of increased accuracy, i.e., since it is common to specify the optical index of various materials for yellow "D" light, refractive power measurements must also be made by this same wave length for maximum accuracy.

When the instrument is equipped with a green filter, compensation must be incorporated in the calibration for the difference in focal distances between yellow and green wave lengths. This compensation can be made for testing lenses of only one index, i.e., if the instrument is calibrated for testing ophthalmic crown and then used for testing flint an

error in measurement of 0.0023 diopter will be made for a 0.25 diopter lens. Although this error is small, an instrument of maximum accuracy

Fig. 5

was needed, and the selection of a deep yellow filter permits accurate dioptric measurements regardless of the index of the test sample to be evaluated.

SUMMARY

A new vertex focometer has been developed for the purpose of accurately testing the optical quality of large plastic visors required for high altitude and high speed flight. This instrument is designed for the measurement of small variations from zero dioptric power of optical sections. The focometer described is calibrated to measure refractive power in hundredths of a diopter and prismatic power in tenths of a prism diopter.

SEX DIFFERENCES IN THE INCIDENCE OF VARIOUS GRADES OF MYOPIA*

Monroe J. Hirsch†
Los Angeles College of Optometry
Los Angeles, California

This communication presents data on the relative incidence of various degrees of myopia in men and women so selected and in such numbers as to permit a statistical check on the differences encountered. Most workers have claimed that low and moderate degrees of myopia are more common among men than among women, while high myopia is more common among women. The actual values considered as "low," "moderate" or "high" has varied among authors, but 6.00 D. has usually been taken as the dividing line above which myopia has been considered high. Many authors including the writer (1950) have postulated that myopia less than 6.00 D. is chiefly due to physiological causes or to biological variation, while higher myopia is congenital or degenerative. It is hoped to give further consideration to the implications of these relations at a later time; for the present the data are made available for other workers.

Since the higher grades of myopia are uncommon, a large sample is necessary to furnish enough cases for reliable relative values and to permit the determination of statistical significance. The data were obtained from the records of the visual examination of 5,201 randomly selected patients between the ages of 18 and 50.‡ The equivalent sphere for each eye was determined from the subjective examination (maximum plus for best acuity) and these values were averaged. Although this method of using the average power of the four major meridians (two for each eye) as a measure of refractive state may be criticized,§ it is still the most satisfactory method of preparing refractive data for statistical analysis.

---

*Submitted on October 21, 1952, for publication in the March, 1953, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

†Optometrist. Ph.D. Member of faculty. Fellow, American Academy of Optometry.

‡Los Angeles College of Optometry Clinic. The author expresses gratitude to Dr. William Brisbane who helped in the laborious task of tabulating the data, and to Professor Frank W. Weymouth for many useful suggestions during the preparation of this study.

§No method of reducing refractive data to a single value is without disadvantages. A major criticism of the method of averaging the power of the two meridians of an eye is the fact that patients with high degrees of mixed astigmatism are classified as near emmetropes; the method of averaging the values for right and left eyes is criticized because antimetropes are classified as emmetropes.

The results are presented in Table I. The columns labeled "N" give the number of cases while the columns labeled "%" indicate the percentage of each sex having each of the refractive states. The last column headed "Ratio" gives the number of women per 100 men with each of the refractive states. Inspection of the Table leads to the following general conclusions:

TABLE I
INCIDENCE OF REFRACTIVE STATUS FOR MEN AND WOMEN

Refraction	Men N	Men %	Women N	Women %	Ratio: No. of women per 100 men
More than 7.00 D. of myopia	7	0.27	12	0.46	170
—6.00 to —7.00 D.	4	0.16	14	0.53	331
* (more than 6.00 D. of myopia)	11	0.43	26	0.99	230
—5.01 to —6.00	16	0.62	12	0.46	74
—4.01 to —5.00	33	1.28	26	0.99	77
—3.01 to —4.00	54	2.10	45	1.71	81
—2.01 to —3.00	120	4.66	90	3.42	73
—1.01 to —2.00	219	8.51	182	6.93	81
—0.01 to —1.00	640	24.86	574	21.85	88
0.00 and all + corrections	1481	57.54	1672	63.65	111
	2574	100.00	2627	100.00	

*Because the two groups of higher myopes are each poorly represented in the sample, it is best to combine these and speak solely of myopes of more than 6.00 D.

(a) The clinic at the Los Angeles College of Optometry seems to have an almost equal number of men and women patients within the age range being considered, there being only 53 women more than men in the random sample of 5,201 patients.

(b) The two groups with the highest degrees of myopia were predominantly women. If these two groups are combined and myopes of more than 6.00 D. considered as a single group there are more than twice as many women as men in this category.

(c) For myopes of less than 6.00 D. there is a greater incidence among men than among women, there being only about eight women for every ten men in this group.

(d) The column of "Ratios" indicates a distinct difference for myopes above 6.00 D. and those below 6.00 D. This sharp difference serves as further evidence for the existence of two types of myopia with approximately 6.00 D. as the dividing line between them.

The data are presented in Table II as a chi square contingency

table. The numbers represent the number of patients while those in parentheses represent the numbers to be expected on the basis of the marginal totals if an absence of relationship is postulated. The value of chi square is 28.46, while a value of 13.82 would be significant to the .001 level. Thus, it seems safe to conclude that the differences in refraction between men and women could not have occurred by chance, and a real difference exists. Inspection of the Table reveals that among the higher myopes there were more women (and fewer men) than would be expected by chance: among the moderate myopes (between emmetropia and 6.00 D.) there were more men (and fewer women) than would be expected by chance: for the emmetropes and hyperopes, there were more women (and fewer men) than would have occurred due to sampling.

TABLE II—CHI SQUARE CONTINGENCY TABLE

	Men	Women	
More than 6.00 D. of myopia	11 (18)	26 (19)	37
Myopia of less than 6.00 D.	1082 (995)	929 (1016)	2011
Emmetropes and hyperopes	1481 (1561)	1672 (1592)	3153
	2.574	2.627	5.201

The values in parentheses are the numbers expected by chance from the marginal totals.

SUMMARY AND CONCLUSIONS

On the basis of the 5,201 records studied, a highly significant sex difference in the distribution of myopia has been demonstrated. Among myopes of more than 6.00 D. there are more than twice as many women as there are men. Among myopes of less than 6.00 D. there are approximately eight women for every ten men. Thus, the classical view that high myopia is more frequent among women while lower myopia is more prevalent among men is borne out by the experience of the Los Angeles College of Optometry Clinic.

The sudden shift in ratios at 6.00 D. offers a clinical rationale for the usual custom of using this point as a dividing line between two clinical types of myopia.

The theoretical importance of the present data may be briefly stated: In a previous paper, An Analysis of Inhomogeneity of Myopia in Adults,* the author postulated the existence of a number of types of myopia. It was predicted that low and moderate myopia were

*Am. J. Optom. & Arch. Am. Acad. Optom., 27.11. 562-571. 1950.

due to either physiological causes, biological variation, or to some interference with the normal growth process. Apparently this type of myopia is more common among men than among women, a fact which may later serve as a clue to its cause. Higher myopia (termed degenerative by Duke-Elder) is also a distinct clinical entity, and is here shown to be more prevalent among women. In the paper referred to above, the differentiation of the types of myopia was made on the basis of a statistical analysis of the distribution curve and it was pointed out that further confirmation of the theory would have to come from clinical observations. The present study offers one such bit of confirming evidence.

BOOK NOTICE

THE AMES DEMONSTRATIONS IN PERCEPTION. William H. Ittelson. Princeton Univ. Press, Princeton, N. J., 1952, $4.00.

Adelbert Ames, Jr., who was responsible for the formation and development of the Dartmouth Eye Institute, has originated several fascinating demonstrations in perception under the auspices of the Institute for Associated Research, Hanover, N. H., with financial assistance from the Rockefeller Foundation and other sources.

This volume describes the material and gives detailed information, aided by many drawings and photographs, which will enable a competent laboratory technician to construct the apparatus necessary for the demonstrations. Included also is a brief account of how to operate the apparatus and some typical observations are presented with each demonstration.

There are a total of 20 demonstrations such as size-brightness, overlay, parallax, after image, artificial retina, tilting screen, distorted rooms, rotating trapezoidal window, etc. The demonstrations make it possible to observe perceptual phenomena ranging from the simplest visual experiences to very complex situations involving action. Each demonstration constitutes a scientific inquiry into a particular controlled concrete visual situation in which certain aspects are held constant while other aspects are varied and the effect of such variations may be qualitatively determined. Investigative and educational use of the demonstrations in the fields of art, architecture, education, psychology, psychiatry, philosophy, optometry and related fields is indicated by the references provided in the bibliography appended at the end of the text.

ROBERT E. BANNON.

MISCELLANEOUS OPTOMETRIC DATA ON TWINS*

Henry W. Hofstetter†
Division of Optometry, Indiana University
Bloomington, Indiana
and
David C. Rife‡
Medical School, The Ohio State University
Columbus, Ohio

INTRODUCTION

The difficulty of collecting twin data under consistent and rigorous testing conditions, and the problem of establishing the type of twinship, i.e., whether the twins are monozygotic or dizygotic, have permitted only very limited reports of the similarity or dissimilarity of ocular conditions in twins. Oberhoff,[1] for example, reported great similarity in the degree of hyperopia and the degree and type of hyperopic astigmatism in two pair of single-ovum (monozygotic) twins. Skeffington,[2] reported a considerable difference in the degree of myopia in a pair of twins believed to be monozygotic. Lisch[3] reported high myopic findings for both members of a pair of long separated adult single-ovum twins pursuing very different occupations, one being a seamstress and the other an agricultural worker. Jancke and Holste[4] made a survey of 72 pairs of single-ovum twins and 68 pairs of two-ovum twins but reported only the types rather than the magnitudes of the refractive anomalies, and made their analysis of the relative influences of heredity and environment in terms of the degree of concordance and discordance in types. The single-ovum twins showed a striking preponderance of concordance in hyperopia and myopia. Astigmatism however seemed to be influenced somewhat by environmental factors. Gates,[5] in an extensive survey of the literature on inheritance of ocular conditions, included a number of twin reports on a variety of ocular conditions. The survey indicated that most of the quantitative data obtainable in a routine optometric examination have not been systematically dealt with, and most of the data that have been made available are not highly conclusive.

The present paper is an attempt to make a methodical analysis

*Submitted on January 5, 1953, for publication in the March, 1953, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.
†Optometrist, Ph.D. Professor and Director of Division of Optometry. Fellow, American Academy of Optometry.
‡Ph.D. Professor and Chairman of the Institute of Genetics.

of data obtained in an accumulation of optometric examination records on a relatively large number of twins.

PROCEDURE

Over a period of several years the junior author accumulated the optometric examination records of 27 pairs of twins classified as identical and 12 pairs of twins classified as fraternal. The classifications were made on the basis of a battery of tests involving hand prints, blood types, pigmentation, skeletal measurements, features, and history of fetal membranes. No doubtful classifications were included in either group.

The optometric examinations were made by several senior students in the Ohio State University School of Optometry. The students frequently worked in pairs, one examining one twin and the other examining the opposite twin. The examinations on each pair of twins were not made consistently with the same equipment or even the same type of equipment. Because the examinations were made at various times in a period of several years, 1936-39, during which the clinical routine taught at the School of Optometry was undergoing a series of developmental changes, the accumulated examination records did not represent identical batteries of tests. In general the students followed the routine examination procedures and criteria that were in current use at the optometry clinic.

The students made their examinations in fulfillment of individual research projects and so were not aware of the probability that their results would be grouped together for a statistical study. Hence they were free to design their own variations of tests for the specific purpose of comparing the two members of a single pair of twins. The several who participated in this research represented superior and highly competent students.

The great majority of the twins included in this report were of college age. The average age for the identicals was 19.4 years, the youngest pair being 8 and the oldest 28 years. The average age for the fraternal group was 24.7 years, the youngest pair being 8 and the oldest pair being 70. Except for three or four extreme ages in each group the twins were between 13 and 25 years old. Careful inspection of the data did not indicate that age was a significant factor in the analyses.

Both groups were almost equally divided with respect to sex.

The optometric findings employed in this report were as follows:

1. The interpupillary distance.
2. The ophthalmometer readings.
3. The subjectively determined lens correction at six meters.
4. Phorias at six meters.

5. Phorias at 40 centimeters.
6. Prism base-in-to-break at six meters.

Items 4, 5, and 6 were taken through the subjectively determined lens correction (item 3, above).

The errors of measurement could not be evaluated from the data provided. For practical purposes it may be assumed however that the measurement errors present in these records compare favorably with those ordinarily met within optometric practice. The above selection of data represents those for which the test procedures might be considered to show reasonable uniformity. Certain other findings were arbitrarily excluded because they are known to vary widely with the examiners' techniques and instructions.

As a simple method of presenting the data the double-entry symmetrical scatterplot method was employed, as previously described by Hofstetter.[6]

In the case of the simple binocular findings such as the phorias, ductions, and interpupillary distances, each pair of observations is entered twice in the scatterplot, the coordinates of the second entry being the same values as for the first entry except that their orders are reversed. For example, if measurements of the interpupillary distances of a pair of twins are found to be 59 and 61 millimeters, these two values are entered in the conventional XY scatter diagram as $X = 59$ and $Y = 61$, and also as $X = 61$ and $Y = 59$. If N is the number of pairs of twins,

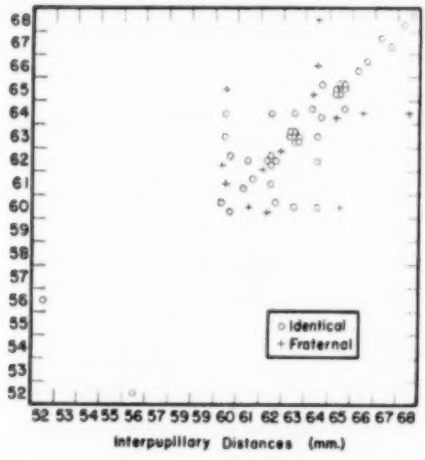


Fig. 1. Double-entry scatterplot of the interpupillary distances in 20 pair of identical twins and 7 pair of fraternal twins. The one set of very low findings in the lower left corner of the graph is from an adult pair of twins.

there will then be 2N entries or points in the scatter diagram. This procedure eliminates the necessity of taking special precautions to insure randomness in assigning each twin to a coordinate. Figures 1, 2, 3, and 4 are examples of double-entry scatterplots for simple binocular traits.

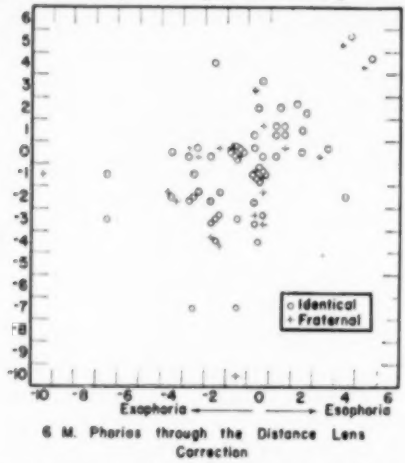


Fig. 2. Double entry scatterplot of the six-meter phoria in 24 pair of identical twins and 11 pair of fraternal twins. Scale units are prism-diopters.

In the case of monocular traits the symmetrical scatterplot has four entries for each set of twins, since there are two findings for each twin.

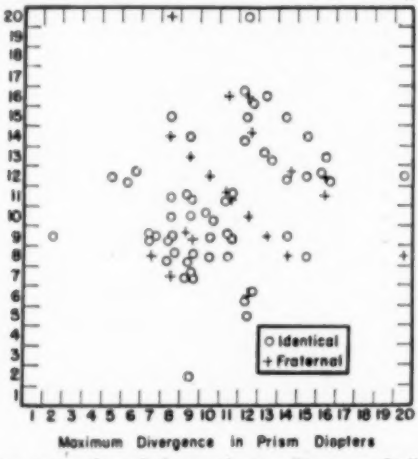


Fig. 3. Double entry scatterplot of the maximum divergence findings in 27 pair of identical twins and 11 pair of fraternal twins.

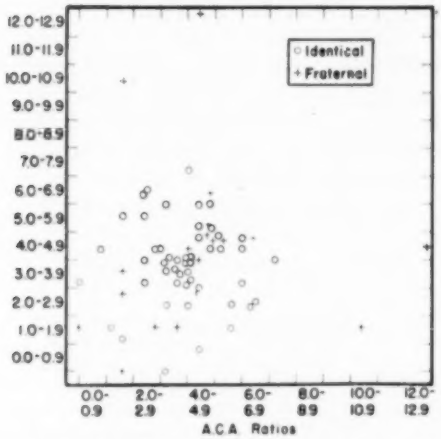


Fig. 4. Double entry scatterplot of the ratios of accommodative convergence to accommodation in 25 pair of identical twins and nine pair of fraternal twins. The ratio units represent accommodative convergence in prism diopters and accommodation in diopters.

The analysis of monocular traits is complicated by the fact that the comparison may be made between *homolateral* eyes (the right eye of one twin with the right of the other and the left eye of the former with the left eye of the latter), or between *heterolateral* eyes (the right eye of one twin with the left of the other and the left eye of the former with the right eye of the latter). The *homolateral* comparison technique tests the sim-

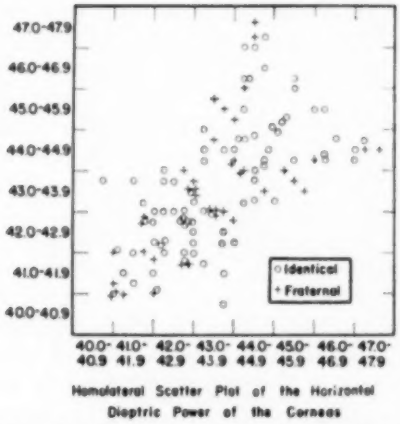


Fig. 5. Symmetrical homolateral scatterplot of the horizontal dioptric powers of the corneas in 20 pair of identical twins and 10 pair of fraternal twins.

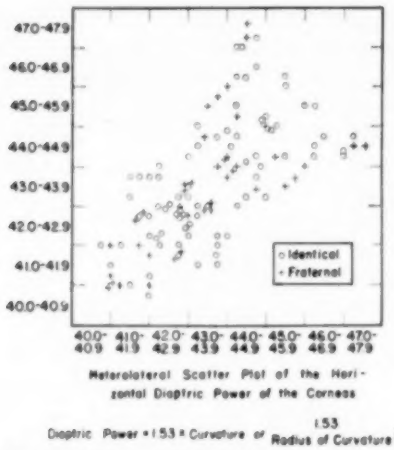


Fig. 6. Symmetrical heterolateral scatterplot of the horizontal dioptric powers of the corneas in the same sample as represented in Fig. 5.

ilarity of twins as direct duplicates of each other, whereas the *heterolateral* comparison technique tests the similarity of twins as reversed or "mirrored" images of each other.

A supplementary analysis of the same monocular data can be made by what is called a *bilateral* scatterplot (the right eye of one twin with the left eye of the same twin, and the right eye of the second twin with

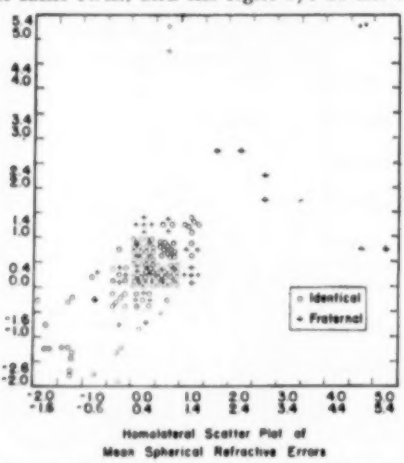


Fig. 7. Symmetrical homolateral scatterplot of the mean spherical refractive errors in 27 pair of identical twins and 12 pair of fraternal twins. The scale values are in diopters, *plus* values representing hyperopia and *minus* representing myopia.

the left eye of the second twin, etc.). In a rigorously controlled experiment this analysis is useful in comparing the degree of similarity of a pair of eyes in the same twin with the degree of similarity in two eyes belonging to the separate twins of the same pair. In this survey the two eyes of each member of a given pair of twins were always examined by one examiner whereas the two members of each pair were often examined by different examiners and with different equipment. Hence the *bilateral* scatterplots would bear no significance as a part of this twin study and so are not included in this report.

Figures 5, 7, 9, and 11 represent *homolateral* scatterplots, and Figures 6, 8, 10 and 12 represent *heterolateral* scatterplots.

In so far as the scatterplots lend themselves to statistical correlation treatment the relationships could also be expressed in terms of the correlation coefficients obtained. As previously pointed out,[6] however, the double-entry method for finding a correlation coefficient does not readily permit an evaluation of the degree of significance of the correlation. Since the limited purposes of this paper are adequately served by the graphical presentations the correlation coefficients have not been included.

RESULTS

The usable data from this collection are classified or evaluated in terms of the following traits:

A. Binocular
   1. Interpupillary distance (Fig. 1)
   2. Six meter phoria through the distance lens correction (Fig. 2)
   3. Maximum divergence in prism diopters (Fig. 3)
   4. The ratio of accommodative convergence to accommodation (Fig. 4)

B. Monocular
   5. Horizontal dioptric powers of the corneas. (Figs. 5-6)
   6. Mean spherical refractive error (Figs. 7-8)
   7. Corneal or ophthalmometric astigmatism (Figs. 9-10)
   8. Total astigmatism (Figs. 11-12)

1. Interpupillary distance.

The interpupillary distance, or "P.D.," represents the distance between the centers of the two pupils when the lines of sight are parallel. Measurements were specified to the nearest millimeter.

A high degree of similarity is apparent in the identical twins. A considerably lower degree of similarity is apparent in the fraternal twins, but the small number of pairs of fraternal twins does not permit an evaluation of the significance of this difference.

2. *Six meter phoria through the distance lens correction.*

The phoria represents the divergence (exophoria) or convergence (esophoria) of the lines of sight of the two eyes under dissociation, relative to fixation of a target at six meters. The correlation is very low but probably significant statistically. A difference between fraternal and identical twins is not evident.

3. *Maximum divergence in prism diopters.*

This test, the base-in-prism limit of clear single binocular vision with the fixation target at six meters, is generally regarded as a correlate of the six meter phoria, and somewhat more reliable. The correlation for the identical twins is very low, similar to that of the phorias in Figure 2. The fraternal twins show no correlation at all.

4. *The ratio of accommodative convergence to accommodation.*

This trait, commonly called the A.C.A. ratio, represents the change in convergence induced by change in accommodation when the eyes are dissociated. It may be approximately derived from routine clinical findings by computing the ratio of change in convergence to change in accommodation in going from the phoria test at 6 M. to the phoria test at 40 cm., provided special care is taken to control the accommodation during the test, and provided further that proximal convergence effects due to the awareness of the change in target distance are held to a minimum. Unfortunately neither of these precautions are assured in the present data. The scatterplot shows no correlation at all.

5. *Horizontal dioptric power of the corneas.*

The horizontal dioptric power of the cornea is a reciprocal function of the radius of curvature and therefore represents a simple and direct structural measurement of the eye. Both the homolateral and heterolateral scatterplots show a marked correlation for the identical twins and a somewhat lower but probably significant correlation for the fraternals.

6. *Mean spherical refractive error.*

The mean spherical refractive error represents the average dioptric power in the two principal meridians of a lens prescription representing the optical correction for distance fixation with accommodation relaxed. This measurement is a resultant function of a number of separate traits including shape and size of the eye, indices of refraction of the media, and intra-ocular muscle tonus.

Both the homolateral and heterolateral scatterplots of this function show a marked correlation among the identical twins and a lesser correlation among the fraternals.

7. *Corneal Astigmatism.*

Corneal astigmatism, the principal component of the total astig-

matism of the eye, is a direct function of the difference in curvature in the two principal meridians of the cornea. Both the homolateral and the heterolateral scatterplots show no significant correlation among either the identicals or the fraternals.

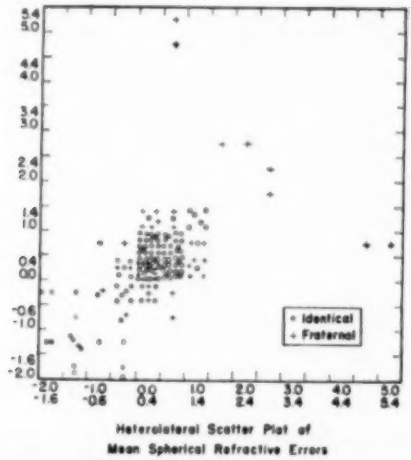


Fig. 8. Symmetrical heterolateral scatterplot of the mean spherical refractive errors in the same sample shown in Fig. 9.

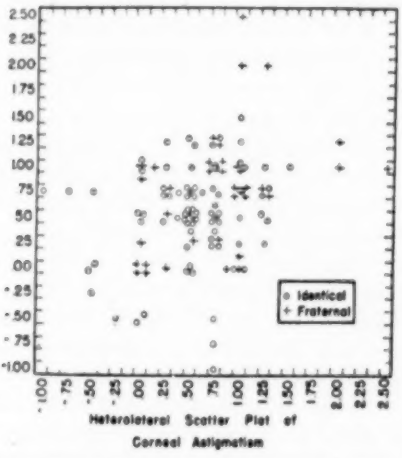


Fig. 9. Symmetrical homolateral scatterplot of the corneal astigmatism in 20 pair of identical twins and 10 pair of fraternals. The scale units represent the dioptric power of the cornea in the principal meridian nearest the vertical minus the power in the principal meridian nearest the horizontal.

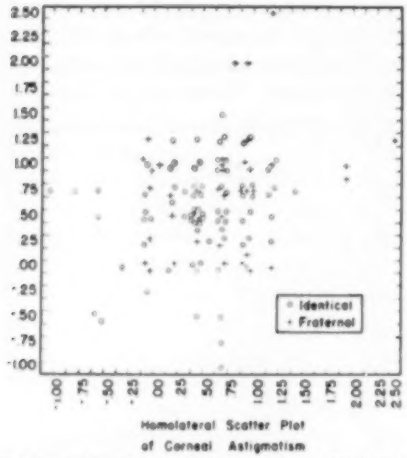


Fig. 10. Symmetrical heterolateral scatterplots of the corneal astigmatism in the same sample as represented in Fig. 7.

8. Total astigmatism.

The total astigmatism represents the resultant astigmatism from all contributing factors, among which the previously mentioned corneal astigmatism is the principal factor.

Both the homolateral and heterolateral scatterplots of total astigmatism show only a very low positive correlation for the identical twins, and approximately zero correlation for the fraternal twins.

DISCUSSION OF RESULTS

The limitations of the method of collecting these data make it seem unwise to draw any conclusions based on absolute correlation values. It is in fact for this reason that the mathematically derived correlation coefficients are not included as a part of this report, lest these absolute values be lifted inadvertently from context to support or repudiate unwarrantedly another thesis. Outside of any theoretical considerations however, the absolute magnitudes of correlation have some degree of practical clinical significance. It is apparent, for example, that none of the optometrically determined traits considered in this survey would serve to identify the type of twinship. Conversely, the awareness of twinship, either fraternal or identical, would not enable clinically useful predictions to be made from one twin to the other. It may well be pointed out that more rigorous testing methods might elicit higher and truer correlations than appear here. This possibility is supported for example by the remarkably higher correlation of A.C.A. ratios in iden-

tical twins found in a separate more rigorously controlled study by Hofstetter.[6] It must be kept in mind however, that the A.C.A. ratio is a difficult trait to measure accurately, especially as compared to the reliability and validity of measurement characteristic of most of the other traits considered here.

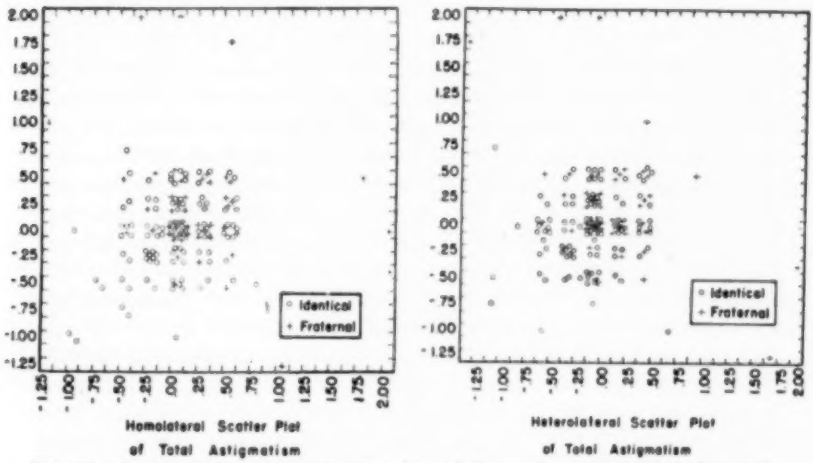


Fig. 11. Symmetrical homolateral scatterplots of the total astigmatism of the eye in 27 pair of identical twins and 12 pair of fraternal twins. The scale readings represent the dioptric power of the eye in the principal meridian nearest the vertical minus the power in the principal meridian nearest the horizontal.

Fig. 12. Symmetrical heterolateral scatterplot of the total ocular astigmatism in the same sample represented in Fig. 11.

On the other hand, it must also be pointed out that the method of collecting these data might induce pseudo-correlations in certain of the traits. When one pair of twins is examined by one examiner with one set of equipment on one date, and another set of instruments on another date, similarities within each pair of twins which would not be duplicated in the other pair might well be manifested in the findings even in the absence of real differences between the two pair of twins. That apparent correlations in the corneal curvature data (Figures 5-6) could easily have been contributed to by variations in the calibration settings in the several ophthalmometers. Similarly, interpupillary distance findings might vary with the tendency of some examiners to read high values, and others low values, with the result that a low degree of intra-twin correlation could easily occur if each pair of twins were examined by a separate examiner.

By the same token, a true correlation can be partly hidden if each member of a pair of twins is examined by a separate examiner. Some of the data reported here were collected through one procedure, and some by the other, and so it may be hoped that there was a degree of neutralization of these effects.

The first of the eight sets of findings, the interpupillary distance, is in effect not really a visual or ocular trait so much as it is a cephalic trait. It shows high correlation among the identicals and fair correlation among the fraternals. The second, third, and fourth sets of findings, the phorias, divergence, and A.C.A. ratio, can be classed as a group of traits primarily related to ocular muscle function. These show very low correlations, usually of doubtful significance. The lack of correlation here may well be due to unreliable test scores. The fifth and sixth sets of findings are related primarily to the size of the eye, and show consistently high correlations among the identical twins and fair correlation among the fraternals. The seventh and eighth sets of findings, which relate to the shape of the cornea, show virtually no correlation. In view of the generally recognized reliability and validity of the astigmatism findings, these low correlations may well represent the true picture. They indeed suggest that astigmatism is almost entirely an environmentally determined trait. If this is true, the clinical implications of this observation are far reaching.

It may be pointed out as an incidental observation that in every set of findings the identical twins showed correlations equal to or higher than those of the fraternal twins.

REFERENCES

[1]Oberhoff, Kurt. Hyperopischer Astigmatismus and Hyperopie bei eineiigen Zwillingen. Klinische Monätsblätter fur Augenhe.lkunde. Vol. 107, December, 1941, pp. 577-580.

[2]Skeffington, A.M., Practical Applied Optometry, Analytical Optometry, Vol. 19, No. 2, February, 1947 (Optometric Extension Program, Duncan, Oklahoma).

[3]Lisch, K., Zur Frage der Myopiegenese. Klinische Monätsblätter fur Augenheilkunde, Vol. 106, June, 1941, pp. 695-699.

[4]Jancke, G. and Holste, A., Der Einfluss von Erblichkeit und Umwelt auf die Refraktionsentstehung. Eine Zwillingsstudie, Klinische Monätsblätter fur Augenheilkunde, Vol. 107, October, 1941, pp. 373-389.

[5]Gates, Reginald R., Human Genetics, Macmillan Co., New York, 1946.

[6]Hofstetter, H. W., Accommodative Convergence in Twins, American Journal of Optometry and Archives of American Academy of Optometry, Vol. 25, No. 10, October, 1948, pp. 480-491.

OCULAR MANIFESTATIONS OF AVITAMINOSIS*

Morton K. Greenspoon†
Sherman Oaks, California

INTRODUCTION

The field of applied nutrition is becoming increasingly important to many branches of science. It is particularly important to the optometrist because he is the general practitioner in the field of human vision. He specializes in the most frequent of visual defects, the refractive error. Corrective lenses and/or orthoptics are often prescribed to remove and control the symptoms of ametropia. It is sometimes the case, however, that after corrective lenses are prescribed some of the symptoms linger on. In a study presented by the American Academy of Nutrition[1] it was found that some of the general symptoms complained of by most patients seeking an optical correction were much improved when a dietary correction was also suggested. Each time the patient eats he holds in his hand a key to his own health and well being. That key is proper nutrition. There is no substitute for the natural vitamins and other nutritional elements that the wise selection of the proper food can bring into the diet. Let us look at the elements which are important to the eye and the visual process.

VITAMIN A

Vitamin A deficiency in man may be due to a direct lack of this factor in the diet, or to an inability to absorb, retain, or release the vitamin from its physiological storage sites. Although a frank vitamin A deficiency is considered uncommon in this country, a considerable portion of the population, according to dietary surveys, does not receive the recommended amounts of vitamin A.[2]

Certain symptoms of vitamin A deficiency were recognized in the middle of the 19th century, and their cause linked to inadequacy of the diet. Observations were made that the nurslings of mothers who fasted were prone to develop spontaneous sloughing of the cornea. Many other reports of keratomalacia from nutritional causes soon followed from all parts of the world.[3]

Experimental observations led to the discovery of vitamin A in 1913.[4] It was found that animals fed an artificial diet with lard as the

*Read before the annual meeting of the American Academy of Optometry, Section on Pathology, Rochester, New York, December 7, 1952. For publication in the March, 1953, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.
†Optometrist.

source of fat developed a nutritional deficiency which could be corrected by the addition to the diet of such substances as butter, milk fat, egg yolk and cod liver oil. One of the outstanding symptoms of this experimental nutritional deficiency was xerophthalmia. It soon became apparent that xerophthalmia in human beings was an aftermath of the decrease in the butter fat content of the diet.

The role of vitamin A in vision is limited to biochemical action at the retina, and in addition this vitamin is known to be concerned with such broad physiological activities as growth, reproduction, and in general the maintenance of the integrity of epithelial tissues. In relation to the eye vitamin A has at least two important functions. It plays an important role in the visual cycle and is essential for the integrity of the epithelial cells of the ocular tissues.

Evidence for the existence of night blindness, or hemeralopia, dates back to antiquity.[2] The potential dangers of this disease are best appreciated when one considers how important it is to recover from the glare of oncoming headlights after having been "blinded" by them. It is impossible to calculate the number of traffic accidents and fatalities caused by this factor alone. Since the symptom of night blindness is one of the first seen in vitamin A deficiency, the measurement of dark adaptation is very useful in enabling the optometrist to make a tentative diagnosis so that he can refer the patient to the proper source to correct the deficiency. Special equipment such as the Bio-photometer or the Feldman Adaptometer is not necessary to make a gross determination of dark adaptation ability. It can be determined in the history by questioning the patient about afterimages of light bulbs, ease of distinguishing objects in a darkened movie theater, incidence of complete blindness as a result of oncoming headlights. It must be remembered that other conditions besides a lack of vitamin A may impair dark adaptation. These are best ruled out if distinct and rapid improvement results after therapeutic doses of vitamin A or an adjustment in the diet to include foods rich in vitamin A.

The severe vitamin A deficiencies which disturb the integrity of the epithelial tissues are rare in this country and appear mostly in areas where deficiency diets are common. Dryness of the cornea and conjunctiva, xerophthalmia, is a manifestation of severe deficiency of vitamin A as are keratomalacia and Bitot's spots. These diseases are common in China, India and Japan, but rare in the United States.[3]

Foods which provide vitamin A activity are: green and yellow vegetables, dairy products and eggs. Ordinary well balanced diets which include the usual amounts of these foods amply meet the daily requirements of vitamin A.

VITAMIN B_1 OR THIAMIN

The optic nerve, like most of the nervous tissues in the body, requires thiamin to function properly. In conditions of deficiency there is probably interference with the carbohydrate metabolism of the nerves and central nervous tissues which results in a polyneuritis, one of the symptoms of the clinical picture of beri-beri.[7] Duke-Elder[8] points out that this condition is closely simulated in chronic alcohol poisoning which itself is frequently associated with marked thiamin deficiency. Alcoholism impairs the absorption of this vitamin due to the damage to the mucus membrane of the alimentary canal and its enzymes, and at the same time, by its high caloric value as a food, it aggravates the relative deficiency by creating a greater need for thiamin. There is evidence that thiamin deficiency is important in the etiology of alcohol neuritis. Severe deficiency of thiamin may cause a host of ocular symptoms including, but not limited to, toxic amblyopia, optic neuritis, bilateral ophthalmoplegia, nystagmus, nuclear ocular palsies of every type and ptosis.

No appreciable amount of thiamin is stored within the body. This suggests the need for adequate amounts of the vitamin in the diet at all times. To retain maximum amounts of the B group such as thiamin it is important for the patient to observe the following rules: Eat raw as many fruits and vegetables as possible. Avoid soaking vegetables in water before cooking them. Cook as many vegetables as possible without peeling. Cook in a small amount of boiling water, and utilize the cooking water from fruits and vegetables. Cook at as low a temperature as possible.[9]

VITAMIN B_2 OR RIBOFLAVIN

Riboflavin is an intensely yellow substance first isolated from milk. It is apparently an essential constituent of the yellow oxidation enzyme. This enzyme is believed to be a phosphoric acid ester of riboflavin in combination with a protein.[10] It functions in cell respiration and is probably a constituent of all cells. There is little storage of B_2, and feeding of large amounts leads only to increased excretion.[11] It is utilized by the body at a slow rate and dietary intake need only be equal to the rate of utilization for a sufficient tissue concentration to be maintained.

The experimental production of an uncomplicated riboflavin deficiency is difficult owing to confusion existing as to the preparation of a diet free of this factor but adequate in all other respects. Day and associates[12] described the development of cataracts in rats, mice, chickens and monkeys deprived of B_2. This condition begins with the appearance

of conjunctivitis and keratitis after 7 or 8 weeks on the deficiency diet, followed by a dullness of the eyeball and finally a definite opacity. The incidence of cataract in this experiment was almost 100%.

Von Euler and Adler[13] isolated riboflavin in the retina of fish eyes and suggested that it may be of special significance in vision.

In 1940 Kruse and co-workers[14] added another feature to the riboflavin deficiency syndrome when it was appreciated that a vitamin B_2 deficiency may cause ocular manifestations. These include photophobia, dimness of vision and actual impairment of visual acuity, congestion of the sclera, vascularization and opacities of the cornea, abnormal pigmentation of the iris, and interstitial keratitis. These lesions responded to the daily administration of from 5 to 10 mgm. of riboflavin. Kruse suggested that the interstitial keratitis which occurs so frequently with congenital syphilis may actually be due to a riboflavin deficiency in as much as some of their patients suffering from keratitis associated with syphilis responded to riboflavin therapy.

Riboflavin is most abundant in milk, egg white, liver and leafy vegetables. Other good sources are heart, pancreas, beef muscle, chicken, apricot and tomatoes. Yeast, although a rich source of the B complex group, varies in its B_2 content.[9]

NIACINAMID OR NICOTINIC ACID

Nicotinic acid has been found necessary metabolically as a coenzyme in intracellular oxidation: It has assumed importance as being at least one factor in the causation of pellagra. The eye picture in a severe deficiency is similar to that of B_1 deficiency.

VITAMIN C OR ASCORBIC ACID

The exact physiological function of vitamin C is unknown. From a study of the symptoms of vitamin C deficiency it becomes apparent that the vitamin is essential for the integrity of certain cells of mesenchymal origin. In the absence of ascorbic acid, the intercellular substance of connective tissue cells is so changed that structural and functional deficiencies result. The collagen of all fibrous tissue, the matrices of bone, dentin and cartilage, and all non-epithelial cement substances including that of the crystalline lens are affected.

The relation of ascorbic acid to the metabolism of the lens is by no means certain. It is known that this vitamin increases the facility with which oxygen is utilized by the lens. It is also known that both the lens and aqueous humor contain ascorbic acid; the amounts varying from 5 to 49 mg. per 100 g. in the former and 3 to 15 mg. for the latter.[15] The mechanism of this accumulation is still uncertain. It has been suggested that the lens actually synthesised ascorbic acid. The fact

that in some species of animals ascorbic acid is not highly concentrated in the lens and aqueous humor and the further fact that vitamin C deficiency does not cause cataract suggests that this substance is not essential to the normal metabolism of the lens.

After a survey of the numerous papers published on the relation of ascorbic acid to cataract formation and in particular the metabolism of the lens, it was impossible to draw any conclusions on the subject. Dietary factors other than ascorbic acid certainly affect the transparency of the lens. Lactose excess and riboflavin deficiency are certainly contributing causes.

Josephson[16] stated that the administration of 15 to 300 mg. of ascorbic acid to patients with cataract caused marked improvement and within a week of treatment mature cataracts became sufficiently transparent to permit examination of the fundus ophthalmoscopically and even permit some vision. Cataracts caused by poisoning with dinitrophenol were said to respond rapidly to treatment with ascorbic acid.

Bellows[17] reported confirmation of the observations of others in respect to cataract formation in rats fed large amounts of galactose, he states that ascorbic acid given with galactose delays the onset of lens changes. It is interesting to note that yeast which is rich in B complex and glutathione but devoid of ascorbic acid also delayed the appearance of cataracts.

It may be concluded that there is not sufficient evidence to warrant generalizations regarding the role of ascorbic acid in lens metabolism.

Systemically a deficiency of vitamin C is known to cause increased capillary fragility because of changes in tissue of the capillary wall. There are several simple clinical tests for checking this.[18] In the eye increased capillary fragility may manifest itself as petechial retinal hemmorhages or subconjunctival hemmorhages.

Vitamin C in its natural form can be obtained from various citrus fruits, tomatoes and raw cabbage.

VITAMIN D, CALCIUM AND PHOSPHORUS

Vitamin D is intimately concerned with the metabolism of calcium and phosphorus in the body. The factors influencing the amount of calcium and phosphorus in the blood are: the dietary intake of intestinal absorption of these elements, the activity of the parathyroid gland, vitamin D and the acid base balance of the blood. Evidence points to the fact that the main function of vitamin D is concerned with the intestinal absorption of calcium and phosphorus. So essential is vitamin D that in its absence, even in the face of sufficient calcium and phosphorus, rickets will result.

Patients on a diet deficient in vitamin D and low in calcium clinically show a weakening in the structure of both the cornea and the sclera. Since these changes may cause a change in the axial length of the eye and thus change its refractive status, it has been suggested that axial myopia may be dependent in part upon a deficiency of calcium, phosphorus and vitamin D. This theory of myopia, as are many other theories as to the etiology of myopia, is open to question.[19]

Foods rich in vitamin D include fish liver oil, fish, egg yolk, liver, milk, cheese and lettuce.

SUMMARY

Until recently, vitamin deficiency was considered a phenomenon observed in animals fed experimental diets, or a syndrome prevalent only in countries where choice of foods was extremely limited. At present, however, it is recognized that vitamin deficiencies are widespread in occurrence and that subclinical deficiencies which warrant specific dietary therapy with proper foods are still more prevalent. We have tried to show how these vitamin deficiencies affect the human eye and vision.

14629 VENTURA BOULEVARD,
SHERMAN OAKS, CALIFORNIA

REFERENCES

[1]Radio Broadcast Nutrition and Your Eyes, Oct. 18, 1951, American Broadcasting Company for American Academy of Nutrition.
[2]Bordens Review of Nutritional Research—Vitamin A, 13, No. 4 (1952).
[3]Bessey, O. A. and Wolbach, S. B. Vitamin A. Physiology and pathology. Journal American Medical Assn., 1938, 110, 2072-2080.
[4]Osborne, T. B. and Mendel, L. B. The relation of growth to the chemical constituents of the diet. Journal Biological Chem., 1913, 15, 311-326.
[5]Hecht, S. and Mendelbaum, J. Relation between vitamin A and dark adaptation. Journal American Medical Assn., 1939, 112, 1910-1960.
[6]Vedder, E. B. The pathology of beri-beri. Journal American Medical Assn., 1938, 110, 893-896.
[7]Jollife, N., Colbert, C., and Joffee, P. M. Observations on the etiological relationship of vitamin B1 to polyneuritis in the alcohol addict. American Journal Medical Science, 1936, 191, 515-526.
[8]Duke-Elder, Sir Stuart, Text Book of Ophthalmology, Vol. 4, p. 4113, 1941, St. Louis.
[9]Today's Nutrition, American Academy of Nutrition, 1952, Los Angeles.
[10]Booker, L. E. Chemical aspects of riboflavin. Journal American Medical Assn., 1938, 110, 1105-1111.
[11]Emmerie, A. On the relation between intake and excretion of flavins. Acta brev. Neerland, 1937, 7, 71-72.
[12]Day, Langston and O'Brien, American Journal Ophthalmology, 1931, 14, 1005.
[13]V. Euler and Adler, Ztschr. F. physiol., 1934, 228.1.
[14]Kruse, H. D., Sydenstriker, V. P., Sobrell, W. H. and Cleckley, H. M. Ocular Manifestations of Ariboflavinosis. Public Health Rep., 1940, 55, 157-169.
[15]Davson, Hugh, The Physiology of the Eye, p. 60, Blackiston Co., Philadelphia, 1949.
[16]Josephson, Science, 1935, 82, 222.
[17]Bellows, Archives of Ophthalmology, 1936, 16, 762.
[18]Walters, J. D., Capillary fragility and allied tests. Ohio State Medical Journal, 1945, 41, 632-633.
[19]Hirsch, M. J. Unpublished notes on Etiology of Refractive Errors, 1951.

THE FITTING OF HIGHLY TORIC CORNEAE WITH TORIC CORNEAL CONTACT LENSES*

Max Schapero†
Los Angeles College of Optometry
Los Angeles, California

It is commonly known that the cornea is not truly spherical, that the corneal curves gradually flatten from the central area to the peripheral area. When measuring corneal curves with an ophthalmometer only an indication of the curves of the cornea in the central area is obtained. The fitting of spherical corneal contact lenses on the basis of such findings, therefore, may or may not prove to be a good fit for that particular cornea depending on how much variation in curvature is present from the central area to the peripheral area. When a cornea has a moderate amount of variation in curvature or manifests moderate amounts of corneal astigmatism it may be adequately fitted with a spherical corneal contact lens. A cornea with considerable variation in radii or highly toric in nature, however, presents a much more difficult problem. Cases in which there is high corneal astigmatism, as determined by objective tests or subjective tests, would fall in this category. Cases of keratoconus, where there are large variations in curvature, also are problems of this type. Occasionally an individual is encountered who manifests little astigmatism with an ophthalmometer, static, or subjective tests, yet still has a highly toric curvature in the more peripheral areas. Such cases can be detected by noting the shape of the cornea which will be oval or resemble a football in shape. Cornea of the above structure cannot be well fitted with spherical lenses.

Spherical corneal contact lenses serve as a compromise fit for the various radii of curvature of the cornea in all of its areas. When the radii vary to a great extent, however, such lenses cannot easily be used as a compromise fit since the difference in radii becomes too great. In attempting to fit a case of this type with a spherical lens, characteristic reactions occur. The lens tends to appear too loose and drop inferiorly as it does not closely conform with the radius in the vertical meridian, but more nearly with that of the horizontal meridian. In attempting to tighten the fit with lenses of shorter radii, to make it hold over the

*Read before the fall seminar of the California Optometric Association and the Los Angeles County Optometric Association, Los Angeles California, November 10, 1952. For publication in the March, 1953, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.
†Optometrist. Member of faculty. Fellow, American Academy of Optometry.

surface of the cornea in a normal riding position, the fit in the horizontal meridian becomes snug while the fit in the vertical meridian still demonstrates considerable lag on superior fixation, dropping readily when the lids are retracted. The point may eventually be reached where a bubble appears, although the lens may still be too loose in the vertical meridian. The bubble forms as the lens has now become too tight for the horizontal meridian. A spherical lens will also form a bubble when fitted to a relatively spherical cornea if the radius of curvature of the lens is too small in comparison to the actual radii of the cornea. However, the appearance of the bubble and fit of the lens in this particular situation is quite different than when a spherical lens forms a bubble when fitted to a highly toric cornea. In the case of a tight spherical lens on a relatively spherical cornea, the bubble tends to be stationary in position and is due to the radii of the cornea being generally longer over its entire surface than that of the lens so that the snugness is relatively the same over the cornea. This causes the lens to be held away from the apex of the cornea and a bubble forms in the central area. This lens will hold firmly on the cornea and offer resistance when attempts to move it are made. The lateral or vertical lag on lateral and vertical eye movements will be practically non-existent.

In contrast to the appearance of the tight spherical lens on a relatively spherical cornea, the spherical lens forming a bubble on a highly toric cornea does not hold firmly in one position but still moves freely and tends even then to drop inferiorly as it still does not conform to the 90 degree meridian. The bubble tends to fluctuate in the 90 degree meridian, and is usually located above the pupillary area. Another characteristic when fitting spherical lenses to highly toric cornea is that in using successively smaller radii the appearance of the fit, initially, does not materially change. An analogy would be fitting lenses of 8.3, 8.2, and 8.1 radii to a cornea requiring 7.7 radius. All would be so loose that no significant change in the fit would be noted.

The statement was previously made that a cornea could not be *well* fitted with a spherical lens if it were highly toric. Of course, a spherical lens may be fitted to a highly toric cornea with a residual looseness in the vertical meridian or with a bubble remaining which does not interfere with vision. The effects of attempting to fit a spherical corneal contact lens to a highly toric cornea has been examined by Baglien* at the Los Angeles College of Optometry. He found that a spherical lens fitted to a highly toric cornea disturbed the corneal tissues to such a degree that it was visible on photographs made with a

*To be published.

keratograph. This instrument is based on a principal similar to that of the Placido's disk, having black and white concentric circles in a hemisphere. Photographs made with this instrument reveal the curvature characteristics of a cornea and how the structure of the cornea is affected by corneal contact lenses. Thus, even though spherical lenses may be crudely fitted to a highly toric cornea, it would not be a recommended procedure.

There has recently been presented to the ophthalmic professions a corneal contact lens with a toric posterior curve.** This posterior curve is molded through the use of dies and any combination of radii may be obtained. The fitting of such lenses to a highly toric cornea permits a much closer relationship to the corneal curves and provides a much better fit both in objective appearance and subjective reaction. Such lenses would be indicated when a spherical corneal lens presents the picture previously mentioned.

The fitting of toric lenses requires a somewhat different fitting procedure than that employed in fitting spherical lenses to relatively spherical cornea: Generally, the fitting procedure is as follows:

1. Use of the ophthalmometer findings as a starting point to determine the approximate radius of curvature in the principal meridians.

2. Insert spherical lenses, commencing with a radius corresponding to the longest corneal radius. Gradually tighten the fit until the lens will hold in the 90 degree meridian, noting the point where the lag in the horizontal meridian is no longer present or until a bubble is first noticed. The lens creating the bubble generally will indicate the approximate fit in the 180 degree meridian. That is, a lens of approximately 0.2 to 0.3 mm. shorter than that of the true fit will cause a bubble. Thus, if a lens of 7.7 mm. radius created a bubble, the fit for the 180 degree will be approximately 8.0 mm.

3. The 90 degree meridian will need a radius of curvature more nearly that of the curvature of the lens creating the bubble (as 7.7). This can be more closely determined by noting the difference in radii as determined by ophthalmometer findings and by noting the degree of looseness of the lens in the vertical meridian.

4. The lens is ordered as determined above (as a 7.6/8.0). The diameter and lens power required is determined in the customary manner.

5. Before this toric lens is inserted in the eye, it should be marked with a small red dot on the periphery to indicate the meridian corresponding to the smallest radius. This can be determined by looking

**Manufactured by the Tru-Fit Contact Lens Laboratory, Los Angeles, California.

through the lens, the tighter meridian will have two "facets" or paraboloid areas near the periphery.

6. Insert the lens and note the objective features of the fit and the position that the red dot assumes on movements of the eye in the various directions, that is, whether it has a relatively constant position or rotates freely. Then remove the lens and reinsert it to determine if the lens will again assume the same position.

(a) If it does: a fairly close fit for the vertical meridian will be present and the dot will tend to come to rest in the area of the 90 degree meridian. Upon eye movements it will rotate approximately ten degrees to either side of this position, depending upon which way the eye moves. By noting the lag of the lens upon vertical and lateral movements it can be determined just how closely the lens fit the 90 and 180 degree meridians. Also the application of fluorescein will assist in determining the fit. If an even layer of fluorescein is present over the entire corneal surface, when the eyelids are retracted, both meridians are equally well fitted.

(b) If the dot does not rest in one position but is quite variable in location, the lens may be either too loose or too tight. If too tight, it will hold snugly to the cornea and may present a bubble. Fluorescein will again indicate the meridians which should be adjusted, also the lag vertically and laterally will help indicate where the tightness lies. If too loose, the lens will still tend to drop especially when the eye fixates superiorly; it will also drop rapidly when moved mechanically with the patient's lower lid; it will demonstrate the characteristic fluorescein pattern for a loose lens and will possibly show excessive lateral lags if the 180 degree meridian is too loose.

Upon observation of these objective signs, appropriate modifications are made in the radii of the lenses employed until a good fit is obtained. This fit will present a much more favorable subjective reaction in addition to the much better objective picture.

Occasionally the fitting of toric corneal lenses will induce some astigmatism, usually a plus cylinder at axis 90 (or minus cylinder, axis 180). This may indicate that the lens is too snug in the 90 degree meridian and the greatest proportion of it can be eliminated when a good overall fit is obtained.

The writer has fitted a number of toric corneal contact lenses to cases where spherical lenses could not be used and has had gratifying success with these.

AMERICAN JOURNAL OF OPTOMETRY
and ARCHIVES *of*
AMERICAN ACADEMY OF OPTOMETRY
Established 1924

Vol. 30 March, 1953 No. 3

EDITORS AND STAFF

Dr. Carel C. Koch ..... *Editor*
Dr. Rudolph Ehrenberg ..... *Research Editor*
Virginia Huck ..... *Editorial Assistant*
Harry Brookins ..... *Advertising and Production Manager*
Mary L. Kerr ..... *Circulation Manager*

Publication and Academy Office: 1502 Foshay Tower, 821 Marquette Ave. Minneapolis 2, Minnesota

Annual Subscription, United States and Canada, $6.00 in Advance; Foreign, $6.50; Single Copies 60c.

Original papers, scientific communications, clinical reports, books for review, and correspondence should be sent to the editor. Subscriptions and applications for single copies should be addressed to the circulation manager. Copy of advertisements must be sent in by the first of the month preceding their appearance. Communications with reference to advertising or other journal business should be addressed to the advertising manager. Academy correspondence should be addressed to Dr. Carel C. Koch, Secretary of the American Academy of Optometry.

Published Monthly by the
AMERICAN JOURNAL OF OPTOMETRY PUBLISHING ASSOCIATION

The American Academy of Optometry and the publishers of this journal have no objection to the reprinting by other magazines of any of the articles in this issue, provided such reprints are properly credited to the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

NEW DEVELOPMENTS IN UNDERGRADUATE EDUCATION

The progress made by our optometric schools in the last few years is the most encouraging single development in optometry. Since World War II most schools and colleges in optometry have engaged in programs to strengthen their faculties and have been quite successful in doing so. In addition, many schools have engaged in building programs or moved to new locations to improve their physical plants.

These developments are somewhat spectacular in themselves and also have a far reaching effect upon the future of the profession. They assure optometry that a steady supply of well trained men will enter optometry in the future and because these men are well grounded in the

basic fundamentals of general science as well as ocular anatomy, physiology, and neurology, they will not succumb to pseudo-scientific theories which harm not only the men themselves but also the profession and the public.

So much has happened in this field during the past six years that a review of the progress already made is in order. All of our schools and colleges have strengthened their faculties during this period and laboratory and clinical training facilities have also been improved. The advancement in teaching methodology is so marked in all of our educational institutions that alumni from classes prior to this period would frequently have difficulty identifying many of the teaching procedures now in use. And this important progress is continuing.

The progress is evident, too, on other fronts. Pennsylvania State College of Optometry is in the midst of a vigorous alumni campaign for funds for a new building program. Northern Illinois College of Optometry and the Department of Optometry at the University of Montreal have reorganized their administration. The School of Optometry at the University of Houston, and the Division of Optometry at Indiana University are new schools in their early development and are off to splendid starts. Both, too, have the strong support of local organized optometry.

During this same period, the Department of Optometry, Columbia University; the Los Angeles College of Optometry; the Massachusetts College of Optometry; the School of Optometry, The Ohio State University; the Ontario College of Optometry; the College of Optometry, Pacific University, and the Southern College of Optometry have all completed building programs or have moved into fine new locations, improving their ability to serve their students and the profession. In each case, this material evidence of progress has been important inasmuch as it signifies to the profession and to education in general the continued advancement of optometry.

The start of 1953 also brings into focus two similar and significant new developments in optometric education. Both will have far-reaching beneficial effects and both will be heartily approved by optometrists everywhere.

The first is the announcement that the School of Optometry, University of California, is now in full occupancy of their new building on the campus at Berkeley, and that the extensive remodeling planned is now completed. In addition, their building is now equipped with the most advanced scientific equipment for research in vision as well as all necessary diagnostic and refractive equipment for teaching the

examining and refracting techniques used in modern optometry and the orthoptic and other specialties which accompany these. The new plant at Berkeley now housing the School of Optometry at the University of California is in keeping with that outstanding University and is in every sense as fine as could be desired.

The second significant announcement of 1953 concerning optometric education comes from the Chicago College of Optometry. This independent optometric college now has entered into an agreement with the Illinois Institute of Technology (formerly Armour Institute of Technology of Chicago) which provides that the Chicago College of Optometry will build a new science laboratory and teaching building adjacent to the Illinois Tech campus while its faculty and student body utilize many of the facilities provided by Illinois Tech. The agreement further provides that the Chicago College of Optometry will retain its own identity as an independent, non-profit optometric college and will confer its own degrees. This new, and we believe excellent, working agreement will prove beneficial both to Chicago College and to Illinois Tech and will enable the student body of the Chicago College of Optometry to enjoy many of the advantages not possible heretofore. The new Chicago College of Optometry building program will start at once.

It is evident from the foregoing that those in charge of our undergraduate educational programs in optometry are taking their responsibility seriously and that their forward looking courses which are developing so rapidly are meeting with profession-wide support. These undergraduate curricula constitute the very foundation upon which the future of optometry rests and this review indicates that in very great part it is secure and in excellent hands. Undergraduate optometric education as supplied today is an accomplishment to which all optometrists can point with pride and these developments merit the continued support of optometrists everywhere.

CAREL C. KOCH

PUBLISHER'S NOTICE—A special subscription service has been arranged to assure subscribers in military service of receiving their copies of this magazine each month. Subscribers are urged to immediately forward changes in their military addresses as these occur, giving name and rank, service unit, hospital, camp, naval port or air base. Also previous address. Journals will be individually forwarded to men in service irrespective of the number of month-to-month changes that occur.

CURRENT COMMENTS

Virginia Huck
Editorial Assistant

Optometrists will confer a favor by sending news items of general interest for this department: such as relate to new instruments, clinical techniques, education, visual health and optometric legislation and organization.

DR. BRIAN O'BRIEN NAMED A O COMPANY RESEARCH VICE PRESIDENT

Dr. Brian O'Brien, noted scientist in the field of physics and optics, has been named vice president in charge of research of the American Optical Company. In order to accept the American Optical Company position, Dr. O'Brien has taken a leave of absence as Director of the University of Rochester Institute of Optics, with which he has been affiliated since 1930.

As Vice President in charge of research, Dr. O'Brien will direct a broad-scope research program in all phases of optics and their application to the products of A. O. Company.

Dr. O'Brien is president of the Optical Society of America, which in 1951 awarded him the Frederic Ives Medal for distinguished work in optics, and the author of more than 50 scientific articles. He holds the degree of Bachelor of Philosophy in Electrical Engineering from Sheffield School of Yale University (1918) and a Ph.D. in physics from the same school (1922).

KNOLL HEADS LOS ANGELES COLLEGE OF OPTOMETRY

Dr. Charles Sheard, who has been serving as interim Dean of the Los Angeles College of Optometry, has relinquished the post, which has been filled by the appointment of Dr. Henry Knoll, L. A. C. O. faculty member and Ph.D. in physiological optics, according to a recent announcement by Dr. Joseph Ziff, president of the board of trustees. Dr. Knoll, who became Dean at the beginning of the Spring Semester in February, has been on the L. A. C. O. faculty since 1950. He is a native of Cliffside Park, New Jersey, received his B.S. at the University of Rochester, Institute of Optics in 1944, his M.S. at the Ohio State University in 1948, and his Ph.D. at Ohio State in 1950. Between 1944-46 he served with the United States Navy at various experimental and research laboratories. He is a member of the American Academy of Optometry, the Optical Society of America, and Sigma Xi.

Dr. Sheard is now serving the College as advisor on the current student procurement program and as special representative to the Board of Trustees.

107TH CONVOCATION AT N. I. C. O.

Ten senior students received the Doctor of Optometry degree, and 44 students the Bachelor of Science in Optometry degree, at Northern Illinois College of Optometry's 107th convocation. At the exercises held January 25th, the honorary Doctor of Ocular Science degree was awarded Sylvester K. Guth, B.S., E.E., in charge of research, Lamp Division, General Electric Company, and Paul Boeder, M.A., Ph.D., Director of Research, American Optical Company, in recognition of their outstanding contributions to the profession of optometry. Dr. Phillip Jackman, Teaneck, New Jersey, presented the convocation address, "Optometry Today," in which he talked of the economic and social problems ahead of the graduating students.

CHICAGO COLLEGE OF OPTOMETRY HOLDS 10TH CONVOCATION

Chicago College of Optometry awarded 33 Doctor of Optometry degrees, 32 Bachelor of Science in Optometry degrees, and one Master of Science in Optometry degree, at its 10th convocation January 23rd. Also, the honorary degree of Doctor of Ocular Science was conferred upon Dr. George H. Warkentine, Cedar Rapids, Iowa, and Dr. Jack G. Copeland, inventor of the Copeland Streak retinoscope. Dr. Warkentine was guest speaker at commencement exercises, talking on the establishment of ethical optometric practices after graduation.

A. O. A. OCCUPATIONAL VISION SEMINAR

The A. O. A. annual occupational vision seminar is being held at Ohio State University March 22-23, 1953, with lectures and panel discussions. Speakers will be Dr. E. H. Westland, Dr. James F. Wahl (president, A. O. A.), Dr. Hedwig H. Kuhn (M.D.), Dr. Merrill J. Allen, Dr. Loring G. Mitten, Dr. Glenn A. Fry, Dr. A. C. Holland, Dr. Gustave Strebel, Dr. J. T. Miller, Sylvester K. Guth, and Dr. Richard Feinberg.

1954 OPTICAL FAIR

Plans for the 1954 Optical Fair are progressing rapidly, according to an announcement by the Fair Committee chairman, Charles F. Oddy, who says it is to be the greatest show the optical industry has ever known. The Fair will be at the Palmer House in Chicago.

SOUTH DAKOTA ANNUAL ASSOCIATION MEETING

South Dakota's State Optometric Association will hold its annual meeting April 26-27, at Huron, with Dr. Henry Hofstetter, Director, Division of Optometry, Indiana University, the principal speaker. Dr.

Rudolph Ehrenberg, president of the National Board of Examiners in Optometry, will speak on "Optometry Looks to the Future." A two-day lecture series by Dr. Louis Jacques will follow the convention proper.

EASTERN STATES CONGRESS

Dr. Thaddeus Murroughs, head of the new laboratory of binocular seeing recently established at Northern Illinois College of Optometry, will lecture on squint and squint training at the Eastern States Optometric Congress to be held at the Hotel Statler, New York City, April 19-21, 1953. Titles of his lectures are, "Basic Considerations in Strabismus," "Paradoxes of Strabismic Vision," and "Testing the Strabismic Patient."

Other Eastern Congress speakers will be Professor John Paul Nafe of Washington University, Dr. Leo Manas (author of Visual Analysis Handbook), Chicago College of Optometry, and Dr. A. M. Skeffington. Dr. Nathan A. Robbins of Buffalo, New York, is general chairman of the Congress.

CALIFORNIA OPTOMETRIC ASSOCIATION ANNUAL MEETING

While the rest of the Journal staff shivered in the ice box of the nation (Minnesota) Editor Carel Koch got some of that glorious California sunshine during the last few days of February. He was not vacationing, however, but rather, was guest speaker at the California Optometric Association annual meeting in Santa Barbara. There, to an audience of more than 500, he outlined his proposed fee structure (as published in the July, 1952, Journal, and subsequent issues), and also talked on the recent activities of the National Interprofessional Committee on Eye Care, of which he is a member. While in California, Dr. Koch also visited the Los Angeles College of Optometry and the School of Optometry, University of California.

Other speakers at the C. O. A. convention were Dr. Monroe J. Hirsch, Los Angeles College of Optometry, Dr. Merton C. Flom, optometrist now working on his Ph.D. at the University of California, and Dr. James Wahl, A. O. A. President.

N. J. O. A. CELEBRATES GOLDEN ANNIVERSARY

The New Jersey Optometric Association celebrated its 50th anniversary January 17th with a banquet in Newark at which several citations were awarded to groups which the association felt had contributed substantially to the welfare of optometry.

The National Interprofessional Committee on Eye Care was cited for "noteworthy achievements in the field of interprofessional relations." Dr. A. Gerard De Voe, ophthalmologist of New York City,

accepted the scroll on behalf of the Committee, of which he is a member. The award was presented by Dr. Harold Simmerman, Wenonah, New Jersey, chairman of the New Jersey Optometric Association Committee on Interprofessional Relations.

Another citation was made to Herbert J. Schoellkopf, chairman of New Jersey Lions Sight Conservation and Blind Committee in recognition of his "exemplary devotion to the highest ideals of service and outstanding contributions to the visual welfare of New Jersey school children." The award was presented by Dr. Herbert L. Moss of Woodbridge, chairman of the N. J. O. A. committee on School Children's Vision. Mr. Schoellkopf is from Pennsauken, New Jersey.

Professor Maurice A. Chaffee, director of Rutgers University Extension Division, accepted a citation on behalf of his institution in "recognition of significant contributions to the conservation of vision and protection of eyes through the Rutgers University Conferences on Occupational Vision." The award was presented by Dr. Phillip Jackman of Hackensack, president of the N. J. O. A.

1953 officers of the association were installed at the dinner, held in Newark, by Dr. James F. Wahl, Anna, Illinois, A. O. A. President. The new officers are Dr. Phillip Jackman, Hackensack, president; Dr. Paul Ellin, Paterson, first vice president; Dr. George M. McEneany, Asbury Park, second vice president; Dr. Ralph L. Marshack, Newark, third vice president; Dr. Peter L. Ehrehardt, Jr., Elizabeth, treasurer; Dr. Leonard Decter, Newark, secretary; Dr. Harold Bookstaber, Montclair, board of trustees chairman; Dr. Henry A. Brzostowski, Bayonne, registrar.

NEWS BRIEFS

Theodore B. Drescher, Vice President of Bausch & Lomb Company, died February 22, 1953, of a heart attack in his home in Rochester, New York, at the age of 58. . . . Northeastern Ohio Lions Clubs have raised $3,500.00 for eye research since the beginning of a campaign this year to build a research fund. Goal for the entire state is $10,000.00. Dr. D. G. Hummel, past president of the American Academy of Optometry is district representative for the Northeastern Lions Clubs fund campaign. . . . Throughout the nation, during the week of March 1 - 7, optometrists worked on programs of "Save Your Vision Week," designed to educate the public on the value of eye care. . . . *Cars* magazine, a new Fawcett publication, featured the view of Dr. James F. Wahl, A. O. A. president, on vision and highway safety, in its first issue. . . . William L. Roberts, 32-year-old optometrist, was named Binghamton,

New York's, Young Man of the Year in recognition of his outstanding civic and professional work in his community during 1952. Dr. Roberts is active in Boy Scouts, the Y. M. C. A., Optimist Club, Junior Chamber of Commerce, county health association work, Community Chest, and many other religious and civic groups. . . . Leslie W. Myers, chairman of the board of the N. P. Benson Optical Company, was awarded the Honorary Doctor of Ocular Science degree by Beta Sigma Kappa, international honorary fraternity in February. Mr. Myers is a director of the Better Vision Institute, national vice chairman of the National Interprofessional Committee on Eye Care, past president of the American Board of Opticianry, and National chairman of the Educational Foundation in Ophthalmic Optics.

SOUTHWESTERN EDUCATIONAL CONGRESS

The thirteenth Annual Southwest Congress was held at the Hotel Texas, Fort Worth, Texas, February 16, with the largest attendance in its history and educational program with five nationally known optometric speakers. Dr. A. M. Skeffington, Dr. N. C. Kephart of Purdue University, Dr. Henry Hofstetter, Indiana University, Dr. H. Ward Ewalt, Jr., Pittsburgh, Pennsylvania, Dr. George Crow, Los Angeles, California. Speakers covered the learning aspects of vision, the visual problems of the mentally defective child, the methods of taking statistically valid findings in optometry, the retarded child, visual training, and the care and retention of visual effectiveness in the presbyope. Public relations problems were also discussed and clinical demonstrations held.

At a Good Fellowship Dinner, seventeen States were represented, delegation from Arkansas, New Mexico, Louisiana and Mississippi, Oklahoma, Iowa, Ohio, Colorado, Florida and Mexico.

General Chairman of the Congress was Dr. Nelson Greeman, Sr., San Antonio, Texas.

INTERPROFESSIONAL COMMITTEE TO HOLD MEETING

The National Interprofessional Committee on Eye Care will hold its Spring meeting at the Hotel Statler, New York City, March 21. Dr. Arthur Culler, ophthalmologist, The Ohio State University, will preside at the meeting. This meeting will follow the annual meeting of the National Society for the Prevention of Blindness.

JOIN*
THE
BVI

Year in, year out, through magazines, newspapers, radio, television, motion pictures . . . the BVI hammers away at public misconceptions about eye care values . . . fights unjust legislation and unfavorable publicity . . . builds the demand for high-quality professional services . . . raises your prestige and income.

Support the voice of *your* industry . . . help it do the work that is more urgently needed every day. Better Vision Institute, Inc., 630 Fifth Avenue, New York 20, N. Y.

**Your Supply House Will Be Glad To Enroll You*

THE NEED FOR EDUCATION NEVER ENDS

BROWCREST

COMBINATION FOR *MEN*

You'll like its popular styling and sleek finish . . . its rich and exclusive Tortone color . . . its strong 4 solder-point bridge . . . its deep grooved, "chip-proofed" eye wire . . . the absence of screws and rivets in the nasal portion. *Order from*

Minnesota Optical Company

Exclusively Supplier — for the Profession

621 WEST LAKE STREET MINNEAPOLIS 8

P. A. B. S.*

Publisher's Authorized Binding for
AMERICAN JOURNAL OF OPTOMETRY
AND ARCHIVES OF
AMERICAN ACADEMY OF OPTOMETRY

Beautifully Bound in Best Grade Washable Buckram
Your Name on Front Cover

$3.15
per volume
in U. S. A. only

Special arrangements have been made by the American Journal of Optometry whereby subscribers can have their copies economically bound to the publisher's specifications.

You can have your issues of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY bound in the best grade of dark green washable buckram with your name imprinted on the front cover in gold.

These personalized and handsomely crafted books, distinctively designed, will prove an asset to your home or office library. They will be a constant source of reference.

Your bound volumes will be returned—transportation prepaid. Ship journals express or parcel post prepaid with remittance to

THE BOOK SHOP BINDERY
Binders of all Journals
308 West Randolph Street **Chicago 6, Illinois**

*Publishers Authorized Binding Service

SOFT-LITE ORTHOGON PANOPTIK!

For **Added** Comfort with **Natural Vision**

With extra leisure hours for televiewing, reading and sewing, today's presbyope is faced with activities which call for control of unwanted light, often a source of visual discomfort under modern lighting conditions. In addition, with a lifetime of established "seeing pattern" behind him, the presbyope appreciates lenses which afford the least possible disturbance to his visual habits.

The lens form which most satisfies all these requirements is the Soft-Lite Orthogon Panoptik. Soft-Lite neutral absorption cuts down glare and unwanted light, while the unique construction features of Panoptiks give youthful, *natural* vision. Panoptik segments are widest at normal reading level; have round corners to match round pupils and waste none of the lens in "blind", or unused areas. And Panoptik's Orthogon curves correct for marginal astigmatism below the limits of physiological perception.

Soft-Lite Orthogon Panoptik

Segment size: 21.5 x 14.5mm. Baryta glass white segment provides greater transmission at near point and reduces seg thickness.

Soft-Lite Orthogon Panoptik (Large Segment)

Segment size: 24 x 17mm. A wider field at reading level with all other Panoptik advantages.

Soft-Lite Orthogon Panoptik (Prism Segment)

Segment size: 21.5 x 14.5mm. Segment size and shape are slightly different from regular Panoptik bifocals. Therefore, PR blanks should be used in both lenses of a pair.

Soft-Lite Orthogon Panoptik (Double Segment)

Lower segment same as regular Soft-Lite Panoptik; upper segment is round. On factory prescription.

Soft-Lite Panoptik Trifocal

Overall segment size: 24 x 17mm; intermediate field, 6.0mm high. Intermediate is 66% of reading addition.

Soft-Lite Panoptik Trifocal (Double Segment)

Lower segment same as regular Soft-Lite Panoptik Trifocal; upper segment is round. On factory prescription.

Soft-Lite Panoptik Fused Lenticular Cataract

Segment size: 20 x 14.0mm. Average diameter of lenticular field: 30mm. Continuous-surface front curve and reduced thickness provide cosmetic and physical advantages. Can be re-surfaced easily to remove scratches or change power within limits.

For added comfort with natural vision...

ORTHOGON *Soft-Lite* PANOPTIK!

The RONSIR

(designed by Shuron)

An all-round masculine frame with smart styling and dependable precision construction.

AVAILABLE IN: 42 44 46 48 Eyes 18 20 22 24 Bridges

Johnson Optical Company

Branch Laboratory
526 Board of Trade Bldg.
DULUTH, MINN.

Main Office and Laboratory
301 Physicians and Surgeons Bldg.
MINNEAPOLIS BR. 3193

THE NEW **Rodenstock**

EYE-REFRACTOMETER

The use of Rodenstock Eye-Refractometer eliminates the time-consuming basic diagnosis, so tiring on the patient. It is particularly in difficult cases, like strong astigmatism, very weak vision, children, illiterates and specially with sensitive and nervous patients that this instrument helps immensely to stimulate the confidence of the patient in the doctor and gives such patients the needed self-confidence.

Range from plus 20.0 D to minus 20.0 D.

ANTON HEILMAN, A.O. 3-53
75 Madison Ave., New York 16, N. Y.
Send information on Rodenstock EYE-REFRACTOMETER.
NAME.....
ADDRESS.....
CITY..... STATE.....

CHICAGO COLLEGE of OPTOMETRY

Accredited by the A.O.A. Council on Education and Professional Guidance.

An outstanding college dedicated to a splendid profession. Located in the world's largest center for teaching in the healing arts.

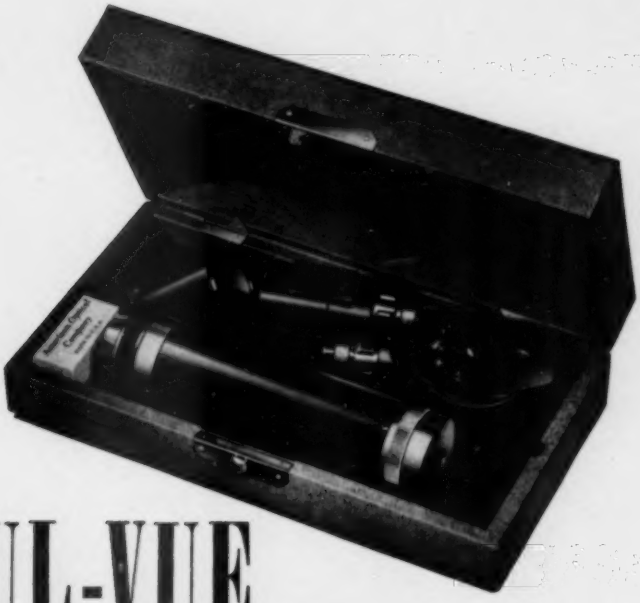
Confers Doctor of Optometry degree.

Entrance requirement: 30 semester credits in specified Liberal Arts courses. Advanced standing available for 30 additional such credits.

General registration in September. Students also permitted to join classes in mid-year.

DR. H. S. WODIS, Registrar

1849-A Larrabee St., Chicago 14, Ill.



AO FUL-VUE

TOMORROW'S INSTRUMENTS... ...TODAY

THE DIAGNOSTIC SET EVERY OPTOMETRIST SHOULD OWN

The new AO Ful-Vue Diagnostic Instruments in this three-piece set have been received enthusiastically by practitioners for their superb performance, handsome appearance, and numerous "features of tomorrow." Ophthalmoscope and Retinoscope heads are combined with medium (or large if desired) handle in a compact leatherette case.

THE AO FUL-VUE OPHTHALMOSCOPE provides complete one-hand control of 23 lens powers, illumination intensity and 5 apertures, red-free, yellow, normal, pinhole, and slit—all from the doctor's side of the instrument.

THE AO FUL-VUE RETINOSCOPE permits both static retinoscopy and dynamic retinoscopy with illuminated target. The semi-silvered mirror reflects more light while retaining desirable softness and freedom from peephole shadow.

Both instruments offer superior optical quality, modern functional design, convenient finger tip rheostat control, and perspiration-proof enamel finish. A new-type bayonet connection permits quick interchange of heads and the prefocused, precentered bulb can be replaced without further adjustment.

Ask to see the AO Ful-Vue Diagnostic Instrument Sets at your first opportunity.

American Optical

INSTRUMENT DIVISION · BUFFALO 15, NEW YORK

FOR THE **KING** *AND* **EYE**

The Shurmont . . . Shuron's sensational new mounting with regal simplicity . . . was designed for "his majesty" (at home, the office or affairs of state) . . . and the Eyes of the World.

RONMAN SHURMONT*

Join the royal acclamation accorded this monarch of rimless mountings . . . a mounting that is making ophthalmic history! NO screws . . . NO effort . . . lenses are held securely by distributed tension and without strain and without contact between glass and metal.

The streamlined bridge is 10K Coral Gold . . . the other parts of this smart mounting are 1/10 12K Gold-Filled over a newly developed alloyed base to give greater resiliency.

In all regular sizes, from Independent Suppliers, NOW

SHURON *for smart frames that like to be compared*

BVI

SHURON OPTICAL COMPANY, INC. ○ GENEVA, N. Y.

*PAT. APPLIED FOR